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ABSTRACT

Intended to put both national and global issues into perspective and help students make decisions about their futures, this supplementary social science activities text provides students with various approaches for thinking about future resources. The program can be integrated into high school classes focusing on government problems, current social issues, world history, American history, economics, and global studies. Twenty-two activities designed to teach students how to analyze, test assumptions, and make decisions offer a context for examining such topics as resources, environment, population, and technology. The first of four major sections, "How to Think about the Future," presents a rationale, views of the future, and activities. In the second section, students explore the past, present, and future from the perspective of a "Great Transition." This concept encourages students to investigate crucial social issues faced by societies as they progress from pre-industrial to post-industrial stages. The third section, "Resources for the Future," presents a new way of looking at resources, four resource issues, and related activities. The final section, "Problem Solving in a Time of Change," deals with social limits to growth, problem solving, understanding global problems, understandable problems, uncertain problems, personal contributions, careers of the future, managers of the future, and related activities. An accompanying teacher's edition provides instructional objectives, ideas for discussion and inquiries, test blanks for each section, and answer keys for all activities. (LH)

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Visions of the Future

Social Science Activities Text

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SS 615 616

VISIONS OF THE FUTURE

A Textbook on the Past, Present and Future

by
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Hudson Institute

With the Special Assistance of:
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This book is dedicated to the Memory of
Herman Kahn

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Preface

The purpose of this book you are about to read is to balance the record of human achievement. In our time there has been a trend in media presentations to emphasize our problems. It is probably accurate to say that "bad news is what is newsworthy." Rock groups sing songs with titles like "Highway to Hell" and "Eve of Destruction." However, predictions of gloom are not new. What is new is the degree of concern with gloom and the ability of the media to spread this message with speed and over great distances.

Our goal is *not* to replace these gloomy predictions with hopeful ones. We are neither pessimists nor optimists. We are realists. The aim of this book is to provide you with the analytical tools and perspective to be realistic as well. The exercises included here are not designed to lead you to conclusions. They are enclosed in order to encourage critical thinking; they will force you to test many of your assumptions and they will be a catalyst for looking at your own life and role in the future.

In one sense this book is different from others you have read. We expect you to be an active participant in an exploration of ideas. We want you to think about your responses, consider various points of view and realize we are *not* offering a vision of the future, but visions of the future. Put yourself in the position of a policy maker. Consider the options available to you. Examine trends and possibilities. Then provide your teachers with well-thought-out answers.

If this book leads to a careful examination of our time and an appreciation of how one makes predictions about the future, we will have achieved our aim. But if it does little more than offer a perspective you haven't considered before, it will still have been well worth our combined effort.

Herbert I. London
Director, Visions of the Future
Hudson Institute

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HOW TO THINK ABOUT THE FUTURE

As soon as you approach your driveway, you realize something is wrong. Where is your robot? Why hasn't it met you as usual?

Oh brother! Does this mean that you will have to carry in all those heavy boxes you brought home? And what about dinner? And . . . Oh well, better go inside and see what's up.

First things first. You insert your personal identification tab in the security computer slot at the front door. The system acknowledges you and flashes, "Welcome home, the door will open." You walk inside and find a note typed into your computer video screen.

"Honey, I'm off early. Should see you Sunday if not sooner. Have to stop up at Orbit-lab on the way back to check out the gravity chamber. I'll call from the launchport if there is any delay.

"P.S. Almost forgot. I'm taking robot Alpha 2 along so I can get some paperwork done while it drives. Hope you can get along by yourself. Be good."

Now you remember. Your spouse had planned a short trip to visit relatives. Some business with the new space lab must have come up at the last minute, too. Now what? You hadn't expected Alpha 2 to be gone also. Who is going to cook? It has been quite a while since you had to fix dinner for yourself. Not since the old robot, Alpha 1, went obsolete three years ago.

You go to the kitchen computer terminal and call up instructions for cooking dinner. After you review the instructions, you ask for today's menu. It reads back: steak, baked potato, and broccoli with butter sauce. Good enough. No need to scan the alternate selections. You remove the special food containers from the freezer, place them in their cooking compartments and press the identification codes so that each will be cooked separately and ready for serving at the same time.

Before you turn away, a bell sounds. The oven reminds you, "Please select 'rare,' 'medium' or 'well done.'" You respond by pushing the appropriate button and sit down for a short wait. Again a bell sounds. This time the oven asks, "Are you ready to begin cooking?" Of course, you forgot. Sheepishly you press the "start" button. Even with all the advances in home technology, machines still must be plugged in, turned on or told to begin.

After dinner you ask the computer for a playback of the evening news that aired an hour ago. Following the news, you check your outstanding bills, then instruct the computer to transfer funds to those accounts that are due. Boy, you think, it sure can get hard to find all the money you need to pay the bills sometimes!

Now it's time for sleep. Before going to bed you remember to set your wake-up call for 6:30 and to program the computer to insure that you don't wake up before coffee is ready and the bathroom has been warmed up for your morning shower. You drift off to sleep.

Just before dawn you hear a pleasant voice calling to you. In the background you are dimly aware of a warbler singing and the busy chattering of squirrels and bluejays. The pleasant voice comes closer. You struggle out of a deep sleep to understand what it is telling you. Suddenly you are awake and you recognize the voice. It is your own, reminding you to get up and start a new day. Last night you recorded that message and put the "forest sounds" tape into the computer's wake-up alarm.

After shower and breakfast, you eye the weather suspiciously. Turbulent black clouds fill the sky. The morning weather report playback predicts heavy rains. It looks like another good day to work here via the office-home computer link.

You sit down at your home terminal and call up the office computer's data banks. A personal code enables only you to access the private project files you have been developing — a design for a tiny laser feedback guidance system that will adapt to personal transport vehicles and help humans to drive "by instrument" when visibility is poor. Your design is almost set, except for one tricky piece of microscopic circuitry. Meanwhile, technicians at your company are already testing some of the finished components. You hope to get a promotion after this project is completed.

On your command, the computer serves up a complex circuit pattern on its video screen. You use the controls to rotate the tangled network of lines, move it all to one side, zoom in on the portion that needs attention and set to your task. Periodically you find that you need to call the data bank for new information and specifications related to your work.

Things are going well. With a little bit of luck you may be able to finish the circuit today and transmit its design to the engineers who will develop the remaining parts.

Midway through the morning, a message light blinks on your screen. It is from your boss. The

"techs" have discovered a failure in one of the laser components. They need you to come to the office.

Too bad. Now the weather has really turned sour. Rain lashes your face the moment you step out the door. As you cautiously maneuver through the storm you think, "This is the second time this week that I've had to make a trip to the office. And in such bad weather. If only I had that laser guide done. Driving would be a lot easier."

Fortunately your office complex has underground parking and an enclosed personal transport system to take you to the testing lab. You'll be there in a few minutes, after a quick stop in the office. And you won't even have to get wet again.

Maybe it isn't so bad. After all, some weeks you don't have to drive to work even one time. And traffic is never very heavy on weekdays, even during the busiest morning times. And it's nice to be able to talk with the techs face-to-face every once in a while. Maybe on the way home you can stop and take a look at the new Alpha 3 — this robot is supposed to be *great* with yard work. Yes, maybe going into the office isn't so bad. As long as you don't have to do it every day. . . .

WHAT VISIONS OF THE FUTURE IS ABOUT

You have just finished reading a scenario about the future. This short episode is one person's version of what the future may include. Is this description similar to what you think the future will be like?

What do *you* think about when you think about the future? Do you think about space travel and spectacular advances in technology? Do you think about the possibility of war among nations? Do you think about how your community might look one hundred years from now? Or, do you think about your own future and what type of career and lifestyle you will have?

This book, *Visions of the Future*, is designed to help you think more intelligently and critically about the future in which you live...a future of new technologies, of new challenges, and of many choices. You are living in the most exciting time in human history. And your outlook and decisions will affect what comes next!

You know that your future is affected by changes in the world around you. You react to what you hear about these changes, but you might not think about them in the same way that you think about more personal questions, like whether to go to college, what career to prepare for, what kind of family you want, and where you would like to live. National and global trends are often complicated, and so it is hard to understand how they can affect you directly. Often, these large issues seem remote and abstract so they become easy to ignore.

The purpose of *Visions of the Future* is to put both national and global issues into perspective, and, at the same time, to help you think intelligently about how your own future fits into this perspective. This book will challenge some of your views; it will give you tools that can help you to become a good judge of what you hear about your community, your nation, and your world; it will help you begin to see your future as part of the "big picture," and, it will ask you to express your opinions.

In this first unit, three ways of looking at the future will be examined. They include:

- Possible Future
- Probable Future
- Preferable Future

VIEWS OF THE FUTURE

> "Man's world, according to a mass of suggestive evidence, hesitates uncertainly today on the threshold of some of the most spectacular changes ever seen. . . . The changes to come . . . will make those witnessed in the momentous historical periods 1500–1650, 1650–1800 and 1800–1950 appear by contrast to be far less remarkable."
>
> Ferdinand Lundberg,
> *The Coming World Transformation* (1963)

Possible Future

The *possible* future includes all events that could happen no matter how small or great the chance. It is possible that you will be so wealthy that you won't know what to do with all your money. It is also possible that you will be unable to even earn a living. Both outcomes are possible, but neither event is very likely. Other possibilities, such as the earth continuing to rotate around the sun and governments continuing to collect taxes, are much more likely. Almost anything that you predict has at least a possibility of occurring in the future.

Probable Future

The *probable* future means events that are likely to happen. Fewer things are probable than are possible. More information is needed to support predictions of the probable future than is needed to support predictions about the possible future.

For example, weather forecasters are people who regularly deal with the probable future. They predict the weather by studying data about the wind, moisture, and air pressure. They make predictions of the probable weather from all the possible weather conditions that could occur. Improvements in data gathering techniques, such as satellite pictures, help weather forecasters to make fairly accurate predictions about the probable weather outlook. Additional facts help people make more accurate predictions.

It is impossible to say what will happen in the future with absolute certainty. Since we cannot be absolutely certain about the future, the events we consider to be the probable future have to be based on what we know has happened in the past, what is currently happening, and on techniques that are used to forecast future events.

How probable is it that people will live in underwater cities? Some people say that this is likely by the year 2050. It may be possible but since we don't currently have many facts about underwater cities, we might decide that it is not probable. As we obtain additional facts about underwater cities we might change our predictions.

The amount and quality of the evidence that we have determine how probable it is that an event will occur. We can only be ***absolutely certain*** about events that have already occurred, like the signing of the Declaration of Independence or who won the last Super Bowl.

However, by analyzing past events we are able to project trends into the future with varying degrees of confidence. If a trend has been developing over many years in many different situations, it seems probable that the trend will continue. For instance, based on past and current events it seems very probable that scientific discoveries will continue to lead to the development of many new technologies. We therefore expect to see increased space travel, better computers, dramatic advances in medicine and many exciting inventions during the next fifty years. We can't be certain that this will occur, but we would be surprised if it did not because the trends leading us to make this prediction have been consistent for some time.

Preferable Future

Another way of thinking about the future is to determine what people ***want*** the future to be. When people state what they would like to happen, they are describing the ***preferable future***. For instance, let us say that you want to see a particular slate of candidates become elected mayor, governor and president, respectively, because you favor their positions on certain issues. You might campaign for these people and you certainly would vote for each of them on election day. In this case, your political and civic activities would be expressions of a preferred future. Facts — such as political polls before an election — can help you to predict how probable it is that the future you prefer will actually occur. And, as the example illustrates, you can make your preferable future more probable by planning, working and making choices with this goal in mind.

However, not all people prefer the same future. So people make different choices and take different

actions based on their personal preferences, or based on what they feel is best for the good of all people. Not everything in the future comes under your control, but to sit back and take no action to create your preferred future is neither reasonable nor responsible.

Predicting The Future

Some people call them dreamers, soothsayers or oracles. Others might call them fortune tellers, prophets, astrologers, forecasters or trend analysts. Whatever they are called, whatever their methods may be, all of these people have one thing in common: they are people who predict the future.

Predicting the future is not a new occupation. Since the very beginning of humankind, people have wanted to know what tomorrow held in store for them. Throughout the ages, people have asked questions about their survival. What will the weather bring next week, or next winter? Will the hunting be good? How long will I live? Will the crops get enough rain and sunshine this season? Will we win the next battle?

Most of these things still concern us today. Recently, however, we have added many new questions. Who will win the presidential election? Will my investment pay off? Whose team will win the championship? Will we run out of resources? Will there be enough food to feed a growing world population? Will the country that supplies our oil become paralyzed by civil war?

Some day you may seek the answer to these questions. If so, the methods you use to reach a decision will determine just what kind of prophet you are.

The ancient art of prediction has come a long way through the course of history. Centuries ago, prophets often spent hours studying animals which they had sacrificed to the gods. By examining the internal organs and entrails for telltale colors, shapes or patterns, they received omens of good or bad luck.

Many other objects and events have also been used for prophecy. The movement of the stars, for example, helps astrologers to make predictions. Other prophets have studied tea leaves, cranial bumps, fire, ashes, drops of water, or the casting of cards and dice. Some relied on dreams, drug-induced visions, or the supernatural help of mystical allies.

Using any of these methods to foretell the future is generally called *divination*. Practitioners of divination interpret omens or rely on supernatural powers to predict coming events.

More modern prediction methods require the study of statistics and trends. Data from this study is then analyzed — often by computer — to give a likely picture of the future. Persons who use this method to tell the future are referred to as *forecasters*.

Forecasters play a prominent role in the modern world. Meteorologists, for instance, gather information on wind patterns, pressure areas, humidity, ocean currents, volcanic eruptions and other global events in order to give us a likely weather forecast. The less data they have to work with, or the farther they must predict into the future, the less reliable their forecasts tend to be.

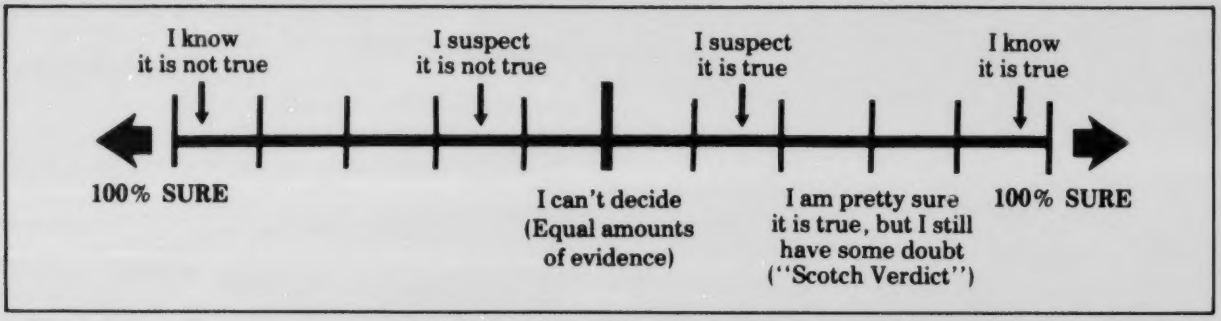
Other kinds of forecasters may analyze economic and business trends to predict stock market gains or the rate at which a country will develop economically. Some poll voters to determine a candidate's chance of success, study demographics to determine population growth rates, or interview doctors and scientists to predict medical breakthroughs for the next decade. Regardless of the subject they study, forecasters must rely on the accuracy of the data they gather in order to paint a likely picture of tomorrow. And forecasters have another thing in common — they are subject to criticism or praise based upon the accuracy of their predictions.

Levels of Certainty

As you know, when people think about the future they can't be absolutely certain about what will take place. However, it is usually possible, by examining facts and trends, to predict how likely something is to happen or to be true. Accurate information helps us to make predictions, but people seldom have enough information to be 100 percent sure of anything.

Herman Kahn, an expert on future studies, used the term "Scotch Verdict" to describe a level of certainty that is useful for making decisions. This term comes from the Scottish legal system, which differs from ours. In Scotland a defendant in court can be found "guilty," "not guilty," or "not been proven guilty." If there is evidence "beyond reasonable doubt," the person is either guilty or not guilty. However, if there is enough evidence to show guilt but not quite enough to end *all* reasonable doubt, the jury

can give a verdict of "not proven." This level of certainty is especially important for predicting the future. People who do not have enough facts to be *absolutely* certain, but do have enough facts to be *almost* certain can take action based on a "Scotch Verdict" (a high level of certainty), but they must also keep looking for new information. The diagram below illustrates this levels of certainty concept.


I know it is not true
I suspect it is not true
I suspect it is true
I know it is true
100% SURE
I can't decide (Equal amounts of evidence)
I am pretty sure it is true, but I still have some doubt ("Scotch Verdict")
100% SURE

It is often necessary for people to take action to influence their future without having absolute certainty concerning what will happen. There are many issues about which they would like to know more, but frequently they must make choices with limited information. So, there is usually at least a possibility that they are making a mistake.

Imagine that you have been saving your money in order to buy a used car. Quite unexpectedly, a friend offers to sell you her car because she needs the money. This is a big decision for you because if you buy this particular car, it will mean that you have to get a part-time job in order to make the required payments. Furthermore, you really like your friend's car, but you don't know how well it runs or how long it will last. What you need is more information about the car in order to make a decision.

Your friend tells you that the car runs great and offers to let you try it out. So, you "test drive" the car and then bring it to a mechanic. Everything seems fine and the mechanic tells you that this is a good car, considering it has been driven for 50,000 miles. The mechanic's statement concerns you so you ask him how long he thinks it will be before the car will need a major repair. After a long speech about various car parts and systems, the mechanic says that with routine maintenance he is pretty sure the car should last another 50,000 miles without much trouble; he also gives you his card "just in case" you need a major repair sooner than that!

In effect, you have asked the mechanic to predict the future. In turn, you will base your decision to buy this car on the information that you have obtained from the mechanic, from your test drive, and from what your friend told you. All the information you have makes you feel pretty sure that the car is okay. You have a "Scotch Verdict" now, so you go ahead and buy it.

Some people are uncomfortable doing anything unless they are absolutely certain about a situation. However, most people are comfortable taking action if they have a "Scotch Verdict" level of certainty — we usually cannot wait for total certainty before we have to act.

What Comes Next?

As individuals and as members of society we must make many choices that help determine our future. The rest of this booklet is designed to give you more information about the past, the present, and the probable future. You will learn how far humankind has advanced in a short period of time, how growth and development occur in countries, about key issues of the future, and about what your role in all of this could be. By using this information as a tool, you will develop a greater understanding of your choices. Throughout your life you will be making choices that affect your future, and the future of your community, your nation, and your world.

ACTIVITIES: HOW TO THINK ABOUT THE FUTURE

ACTIVITY 1

LEVELS OF CERTAINTY ABOUT THE FUTURE

What will the future be like in your lifetime? In your children's lifetime? In your children's children's lifetime? Dramatic changes are possible, and some can be predicted with a degree of certainty. That is, some changes are probable.

Look at the list below. Decide if each event is *possible*. Is it also *probable?* Place a check (√) in the "possible" column if you believe an event *could* happen and a "√" in the "probable" column if you believe the event is likely to happen. Then, decide whether each event is "desirable" or "undesirable."

FUTURE EVENTS	WILL IT OCCUR?		WHAT DO YOU THINK?		WHAT INFORMATION DID YOU BASE YOUR DECISION ON? WHERE CAN YOU GET MORE INFORMATION?
	POSSIBLE	PROBABLE	DESIRABLE	UNDESIRABLE	
1. Underwater cities					
2. More Free Time					
3. Increased crime					
4. Computer-Managed Households					
5. Major Changes in The Weather					
6. New Sources of Energy					
7. Car That Gets 100 Miles Per Gallon					
8. Cure for Cancer					
9. Greater Life Expectancy					
10. End to Poverty					
11. Mining on the Moon					
12. Rising Unemployment					
13. New Types of Food					
14. Increasing Population					
15. 3-Dimensional Television					

ACTIVITY 2

PEOPLE WHO PREDICT THE FUTURE

A. Following this introduction are three short articles. The first article describes a mystic who predicted the future during the sixteenth century and the second article was written by someone who predicted the future during the end of the nineteenth century. The final article offers predictions made very recently by well known authors and scientists. Read the articles and then answer the questions that follow:

(1) Do you believe that people can make reasonably accurate predictions by using "mystical" means such as staring into water, reading tarot cards, or studying astrology?

(2) Are scientists the best predictors? How can a journalist qualify as a predictor of the future? What methods or sources of information might a journalist or author use in order to make predictions?

B. On the lefthand half of a piece of paper, make a list of the predictions that are made by Asimov, Kahn and Cetron in the last article.

On the righthand half of the page, describe a reason given for each prediction. An example is provided below.

Example: **Prediction**	**Reason**
1. 50 years from now there will be more farms, parkland and wilderness. (Asimov)	1. Because industry will be moved into outer space.
2.	2.
3.	3.
4.	4.
5. The economic future of the U.S. looks good. (Kahn)	5. Cost cutting and better use of labor and equipment.
6.	6.
7.	7.
8.	8.
9.	9.
10. The gap between the rich and the poor will shrink. (Cetron)	10. Governments will use taxes to "even things out."
11.	11.
12.	12.
13.	13.
14.	14.
15.	15.

A "Doctor" Who Predicted the Future

Who would expect a doctor to record his prophecies in verse? In the mid-sixteenth century, a man by the name of Nostradamus did just that.

Doctor to France's royal Charles IX, Nostradamus wrote over a thousand poetic verses. In them he enclosed cataclysmic prophecies of events destined to take place hundreds of years in the future. No one is certain how Nostradamus arrived at his predictions, but it is claimed that he saw future events while staring into a water-filled brass bowl.

Some biographers interpret Nostradamus' words to predict many contemporary events such as the deaths of the Kennedy brothers — President John and Senator Robert — in the 1960s. They believe he also foretold the assassination attempt on Pope John Paul II, and predicts a future nuclear battle that will follow another major war. Nostradamus' critics, on the other hand, say that his verses are vague and provide little sense of time.

Here is one sample of his writing (translated) regarding the Pope.

> "Roman Pope do not approach the city which two rivers bathe. Your blood and that of your followers will flow near this place when the rose will flower." . . .

Another example of his verse may be a prediction about Napoleon, who was born to poor parents in Corsica, an island in the Mediterranean:

> "In the southern extremity of Western Europe a child shall be born of poor parents who by his tongue shall seduce the great army. His bruit shall extend to the kingdom of the East."

The Bettman Archive

Harold G. Shane & Gary A. Sojka

JOHN ELFRETH WATKINS, JR.

Forgotten Genius of Forecasting

Since the study of the future began to come of age a few decades ago, there has been considerable evidence to suggest that, as Niels Bohr humorously phrased it, "Prediction is very difficult, especially about the future."

Roy Amara, president of the Institute for the Future, is more precise: "Anything that you forecast is by definition uncertain," he tells us.

In view of the ease with which experts can err, the foresight and forecasts of a forgotten genius, John Elfreth Watkins, Jr., are phenomenal. His projection of developments in science and technology, reprinted here, was first published in *Ladies' Home Journal* in December 1900. The intervening years have provided ample time to verify his prescience, and his record is most impressive.

Watkins used an interview procedure to gather learned opinion for his forecasts—a procedure that in a limited sense anticipated the Delphi technique in that it was a judgment or consensus forecast.

Watkins, son of a curator of technological collections at the U.S. National Museum (now the Smithsonian Institution), was a journalist by profession and about 30 years old when this article was published. He rose to become managing editor of the Philadelphia Ledger Syndicate, which was part of the *Public Ledger*, a highly respected newspaper in its day. Furthermore, he was fortunate to live long enough to see many of his predictions come to fruition prior to his death during World War II.

To appreciate Watkins's forecasts fully, the reader must keep in mind the muscle-power era during which he wrote—an era in which the first automobiles had just appeared on U.S. roads west of the Mississippi River! It was a time in which women and children had virtually no rights, labor was exploited on the farm and in the factory and sweatshop, air travel was a remote dream, lifespans were brief, and the telephone

(Continued on page 10)

John Elfreth Watkins, Jr.

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From *The Ladies' Home Journal*, December 1900

WHAT MAY THE NEXT

An all-but-forgotten journalist wrote some surprisingly accurate forecasts at the turn of the century.

These prophecies will seem strange, almost impossible. Yet they have come from the most learned and conservative minds in America. To the wisest and most careful men in our greatest institutions of science and learning I have gone, asking each in his turn to forecast for me what, in his opinion, will have been wrought in his own field of investigation before the dawn of 2001 — a century from now. These opinions I have carefully transcribed.

Five Hundred Million People. There will probably be from 350,000,000 to 500,000,000 people in America and its possessions by the lapse of another century. Nicaragua will ask for admission to our Union after the completion of the great canal. Mexico will be next. Europe, seeking more territory to the south of us, will cause many of the South and Central American republics to be voted into the Union by their own people.

The American Will Be Taller by from one to two inches. His increase of stature will result from better health, due to vast reforms in medicine, sanitation, food and athletics. He will live fifty years instead of thirty-five as at present—for he will reside in the suburbs. The city house will practically be no more. Building in blocks will be illegal. The trip from suburban home to office will require a few minutes only. A penny will pay the fare.

There Will Be No C, X or Q in our every-day alphabet. They will be abandoned because unnecessary. Spelling by sound will have been adopted, first by the newspapers. English will be a language of condensed words expressing condensed ideas, and will be more extensively spoken than any other. Russian will rank second.

"Hot or cold air will be turned on from spigots to regulate the temperature of a house. Rising early to build the furnace fire will be a task of the olden times."

Hot and Cold Air from Spigots. Hot or cold air will be turned on from spigots to regulate the temperature of a house as we now turn on hot or cold water from spigots to regulate the temperature of the bath. Central plants will supply this cool air and heat to city houses in the same way as now our gas or electricity is furnished. Rising early to build the furnace fire will be a task of the olden times. Homes will have no chimneys, because no smoke will be created within their walls.

No Mosquitoes nor Flies. Insect screens will be unnecessary. Mos-

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HAPPEN IN HUNDRED YEARS

quitoes, house-flies and roaches will have been practically exterminated. Boards of health will have destroyed all mosquito haunts and breeding-grounds, drained all stagnant pools, filled in all swamp-lands, and chemically treated all still-water streams. The extermination of the horse and its stable will reduce the house-fly.

Ready-Cooked Meals Will Be Bought from establishments similar to our bakeries of to-day. They will purchase materials in tremendous wholesale quantities and sell the cooked foods at a price much lower than the cost of individual cooking. Food will be served hot or cold to private houses in pneumatic tubes or automobile wagons. The meal being over, the dishes used will be packed and returned to the cooking establishments where they will be washed. Such wholesale cookery will be done in electric laboratories rather than in kitchens. These laboratories will be equipped with electric stoves, and all sorts of electric devices, such as coffee-grinders, egg-beaters, stirrers, shakers, parers, meat-choppers, meat-saws, potato-mashers, lemon-squeezers, dish-

"No foods will be exposed . . . Refrigerators will keep great quantities of food fresh for long intervals."

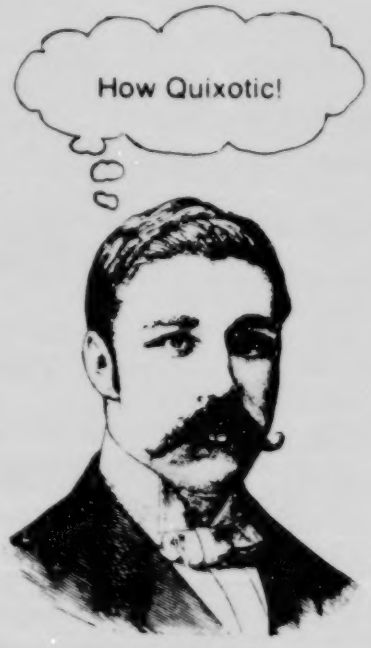
"In most cities hurry traffic will be confined to broad subways or tunnels . . . with 'moving-sidewalk' stairways leading to the top."

washers, dish-dryers and the like. All such utensils will be washed in chemicals fatal to disease microbes. Having one's own cook and purchasing one's own food will be an extravagance.

No Foods Will Be Exposed. Storekeepers who expose food to air breathed out by patrons or to the atmosphere of the busy streets will be arrested with those who sell stale or adulterated produce. Liquid-air refrigerators will keep great quantities of food fresh for long intervals.

Coal Will Not Be Used for Heating or Cooking. It will be scarce, but not entirely exhausted. The earth's hard coal will last until the year 2050 or 2100; its soft-coal mines until 2200 or 2300. Meanwhile both kinds of coal will have become more and more expensive. Man will have found electricity manufactured by water-power to be much cheaper. Every river or creek with any suitable fall will be equipped with water-motors, turning dynamos, making electricity. Along the seacoast will be numerous reservoirs continually filled by waves and tides washing in. Out of these the water will be constantly falling over revolving wheels. All of our restless waters, fresh and salt, will thus be harnessed to do the work which Niagara is doing to-day: making electricity for heat, light and fuel.

There Will Be No Street Cars in Our Large Cities. All hurry traffic will be below or high above ground when brought within city limits. In most cities it will be confined to broad subways or tunnels, well lighted and well ventilated, or to high trestles with "moving-sidewalk" stairways leading to the top. These underground or overhead streets will teem with capacious automobile passenger coaches and freight wagons, with cushioned wheels. Subways or trestles will be reserved for express trains. Cities, therefore, will be free from all noises.



"There will be no C, X, or Q in our everyday alphabet."

and telegraph were deemed to be miracles of modern science.

In view of the changes he was predicting, the number of forecasting "hits" scored by Watkins is astonishing: electric appliances would take over the kitchen; Americans would be taller, live longer, and be more concerned with health and fitness; high-speed trains would travel at 150 miles per hour; and automobiles would replace horses in all their work. Watkins also anticipated the use of planes, tanks, and submarines in warfare and correctly speculated that streetcars would be replaced by elevated trains and subways; that telephones would span the globe; and that cameras would transmit images around the world.

He also foresaw many social changes with remarkable clarity. These included a subsidized university education for every man and woman, and medical aid (along with free lunches) in schools for children of the poor.

In some of the predictions where Watkins went wrong, his mistake was not in the area of technology, but in not foreseeing the unpredictable qualities of humans. For example, Watkins concluded that strawberries might well become as large as apples and that peas would be as big as beets by the twentieth century's end. These prognostications were generally correct with respect to the capacity of modern plant science. However, Watkins did not make enough allowance for consumers' tastes and preferences changing with the passing years. While seed companies periodically have introduced "monster" varieties of, say, tomatoes, they generally have been less popular than those of "normal" appearance and texture—and ultimately tend to disappear from the market.

It would be an interesting venture, some 80 years from now, to review the work of contemporary writers in journals such as THE FUTURIST, in order to see whether their prognostications hold up as well as those of John Elfreth Watkins, Jr.! We doubt that many persons prospecting the future will be as successful as he was. We say this not to belittle contemporary futurists but because Watkins lived at the end of an era of relatively slow technological change. In his day, humans lived and died in more or less the same world into which they had

(Continued on page 12)

"There will be air-ships, but they will not successfully compete with surface cars and water vessels for passenger or freight traffic."

Photographs Will Be Telegraphed from any distance. If there be a battle in China a hundred years hence snapshots of its most striking events will be published in the newspapers an hour later. Even to-day photographs are being telegraphed over short distances. Photographs will reproduce all of Nature's colors.

Trains One Hundred and Fifty Miles an Hour. Trains will run two miles a minute, normally; express trains one hundred and fifty miles an hour. To go from New York to San Francisco will take a day and a night by fast express. There will be cigar-shaped electric locomotives hauling long trains of cars. Cars will, like houses, be artificially cooled. Along the railroads there will be no smoke, no cinders, because coal will neither be carried nor burned. There will be no stops for water. Passengers will travel through hot or dusty country regions with windows down.

Automobiles Will Be Cheaper Than Horses are to-day. Farmers will own automobile hay-wagons, automobile truck-wagons, plows, harrows and hay-rakes. A one-pound motor in one of these vehicles will do the work of a pair of horses or more. Children will ride in automobile sleighs in winter. Automobiles will have been substituted for every horse vehicle now known. There will be, as already exist to-day, automobile hearses, automobile police patrols, automobile ambulances, automobile street sweepers. The horse in harness will be as scarce, if, indeed, not even scarcer, then as the yoked ox is to-day.

Everybody Will Walk Ten Miles. Gymnastics will begin in the nursery, where toys and games will be designed to strengthen the muscles. Exercise will be compulsory in the schools. Every school, college and community will have a complete gymnasium. All cities will have public gymnasiums. A man or woman unable to walk ten miles at a stretch will be regarded as a weakling.

To England in Two Days. Fast electric ships, crossing the ocean at more than a mile a minute, will go from New York to Liverpool in two days. The bodies of these ships will be built above the waves. They will be supported upon runners, somewhat like those of the sleigh. These runners will be very buoyant. Upon their undersides will be apertures expelling jets of air. In this way a film of air will be kept between them and the water's surface. This film, together with the small surface of the runners, will reduce friction against the waves to the smallest possible degree. Propellers turned by electricity will screw themselves through both the water beneath and the air above. Ships with cabins artificially cooled will be entirely fire-

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"The piano will be capable of changing its tone from cheerful to sad. Many devices will add to the emotional effect of music."

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proof. In storm they will dive below the water and there await fair weather.

There Will Be Air-Ships, but they will not successfully compete with surface cars and water vessels for passenger or freight traffic. They will be maintained as deadly war-vessels by all military nations. Some will transport men and goods. Others will be used by scientists making observations at great heights above the earth.

Aerial War-Ships and Forts on Wheels. Giant guns will shoot twenty-five miles or more, and will hurl anywhere within such a radius shells exploding and destroying whole cities. Such guns will be aimed by aid of compasses when used on land or sea, and telescopes when directed from great heights. Fleets of air-ships, hiding themselves with dense, smoky mists, thrown off by themselves as they move, will float over cities, fortifications, camps or fleets. They will surprise foes below by hurling upon them deadly thunderbolts. These aerial war-ships will necessitate bomb-proof forts, protected by great steel plates over their tops as well as their sides. Huge forts on wheels will dash across open spaces at the speed of express trains of to-day. They will make what are now known as cavalry charges. Great automobile plows will dig deep intrenchments as fast as soldiers can occupy them. Rifles will use silent cartridges. Submarine boats submerged for days will be capable of wiping a whole navy off the face of the deep. Balloons and flying machines will carry telescopes of one hundred-mile vision with camera attachments, photographing an enemy within that radius. These photographs, as distinct and large as if taken from across the street, will be lowered to the commanding officer in charge of troops below.

"Automobiles will have been substituted for every horse vehicle now known [including] police patrols."

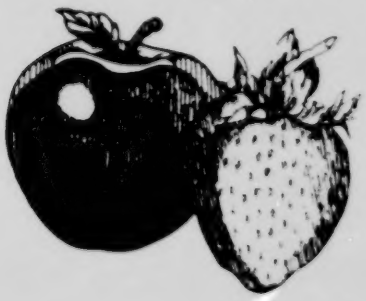
There Will Be No Wild Animals except in menageries. Rats and mice will have been exterminated. The horse will have become practically extinct. A few of high breed will be kept by the rich for racing, hunting and exercise. The automobile will have driven out the horse. Cattle and sheep will have no horns. They will be unable to run faster than the fattened hog of to-day. A century ago the wild hog could outrun a horse. Food animals will be bred to expend practically all of their life energy in producing meat, milk, wool and other by-products. Horns, bones, muscles and lungs will have been neglected.

Man Will See Around the World. Persons and things of all kinds will be brought within focus of cameras connected electrically with screens at opposite ends of circuits, thousands of miles at a span. American audiences in their theatres will view upon huge curtains before them the coronations of kings in Europe or the progress of battles in the Orient. The instrument bringing these distant scenes to the very doors of people will be connected with a giant telephone apparatus transmitting each incidental sound in its appropriate place. Thus the guns of a distant battle will be heard to boom when seen to blaze, and thus the lips of a remote actor or singer will be heard to utter words or music when seen to move.

Telephones Around the World. Wireless telephone and telegraph circuits will span the world. A husband in the middle of the Atlantic will be able to converse with his wife sitting in her boudoir in Chicago. We will be able to telephone to China quite as readily as we now talk from New York to Brooklyn. By an automatic signal they will connect with any circuit in their locality without the intervention of a "hello girl."

"There will be no wild animals except in menageries."

Grand Opera Will Be Telephoned to private homes, and will sound as harmonious as though enjoyed from a theatre box. Automatic instruments reproducing original airs exactly will bring the best music to the families of the untalented. Great



Strawberries as large as apples . . . will be grown upon tall bushes."

been born. To illustrate: if George Washington and Benjamin Franklin could have been transposed from the late eighteenth century to the early twentieth century, they probably would have suffered very little from future shock. Rural America in particular resembled much of the era in which they had lived. Only a few contrivances such as the telephone and the 13,824 automobiles registered in 1900 would have required much explanation.

In the last 40-odd years, however, a rapidly accelerating rate of change has combined with extraordinary technological progress. Biophysicist John Platt presents convincing evidence suggesting that in the past four decades there have been more profound changes than in the previous six centuries. As a result, virtually all adult Americans and many people everywhere have experienced a wrenching psychological and social disorientation that is changing the fabric of their lives and threatening their traditional cultures.

Without in any way demeaning the genius of John Elfreth Watkins, Jr., it seems likely to us that in the 1980s there are far more variables and "human unpredictables" than there were in 1900. At the very least, it now requires considerable temerity to forecast developments even 20 years hence—and Watkins's 100-year prognoses will, perhaps, never be replicated with such phenomenal accuracy. For that reason, we hope that John Elfreth Watkins, Jr., will be remembered as the "seer of the century" because of his extraordinarily accurate images of the world to which we have fallen heir.

About the Authors

Harold G. Shane is university professor of education at Indiana University, Bloomington. A pioneer in educational futurism, his recent books include *The Educational Significance of the Future* (1973), *Curriculum Change Toward the 21st Century* (1977), and *Educating for a New Millennium* ((1981).

Gary A. Sojka is professor of biology and dean of the College of Arts and Sciences at the same institution.

They can be reached through their respective departments, Indiana University, Bloomington, Indiana 47405.

musicians gathered in one inclosure in New York will, by manipulating electric keys, produce at the same time music from instruments arranged in theatres or halls in San Francisco or New Orleans, for instance. Thus will great bands and orchestras give long-distance concerts. In great cities there will be public opera-houses whose singers and musicians are paid from funds endowed by philanthropists and by the government. The piano will be capable of changing its tone from cheerful to sad. Many devices will add to the emotional effect of music.

"Rats and mice will have been exterminated."

How Children Will Be Taught. A university education will be free to every man and woman. Several great national universities will have been established. Children will study a simple English grammar adapted to simplified English, and not copied after the Latin. Time will be saved by grouping like studies. Poor students will be given free board, free clothing and free books if ambitious and actually unable to meet their school and college expenses. Medical inspectors regularly visiting the public schools will furnish poor children free eyeglasses, free dentistry and free medical attention of every kind. The very poor will, when necessary, get free rides to and from school and free lunches between sessions. In vacation time poor children will be taken on trips to various parts of the world. Etiquette and housekeeping will be important studies in the public schools.

Store Purchases by Tube. Pneumatic tubes, instead of store wagons, will deliver packages and bundles. These tubes will collect, deliver and transport mail over certain distances, perhaps for hundreds of miles. They will at first connect with the private houses of the wealthy, then with all homes. Great business establishments will extend them to stations, similar to our branch post-offices of to-day, whence fast automobile vehicles will distribute purchases from house to house.

Vegetables Grown by Electricity. Winter will be turned into summer and night into day by the farmer. In cold weather he will place heat-conducting electric wires under the soil of his garden and thus warm his growing plants. He will also grow large gardens under glass. At night his vegetables will be bathed in powerful electric light, serving, like sunlight, to hasten their growth. Electric currents applied to the soil will make valuable plants grow larger and faster, and will kill troublesome weeds. Rays of colored light will hasten the growth of many plants. Electricity applied to garden seeds will make them sprout and develop unusually early.

Oranges Will Grow in Philadelphia. Fast-flying refrigerators on land and sea will bring delicious

"Delicious oranges will be grown in the suburbs of Philadelphia."

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"Mosquitoes, house-flies and roaches will have been practically exterminated."

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fruits from the tropics and southern temperate zone within a few days. The farmer of South America, South Africa, Australia and the South Sea Islands, whose seasons are directly opposite to ours, will thus supply us in winter with fresh summer foods which cannot be grown here. Scientists will have discovered how to raise here many fruits now confined to much hotter or colder climates. Delicious oranges will be grown in the suburbs of Philadelphia. Cantaloups and other summer fruits will be of such a hardy nature that they can be stored through the winter as potatoes are now.

Strawberries As Large As Apples will be eaten by our great-great-grandchildren for their Christmas dinners a hundred years hence. Raspberries and blackberries will be as large. One will suffice for the fruit course of each person. Strawberries and cranberries will be grown upon tall bushes. Cranberries, gooseberries and currants will be as large as oranges. One cantaloup will supply an entire family. Melons, cherries, grapes, plums, apples, pears, peaches and all berries will be seedless. Figs will be cultivated over the entire United States.

Peas As Large As Beets. Peas and beans will be as large as beets are today. Sugar cane will produce twice as much sugar as the sugar beet now does. Cane will once more be the chief source of our sugar supply. The milkweed will have been developed into a rubber plant. Cheap native rubber will be harvested by machinery all over this country. Plants will be made proof against disease microbes just as readily as man is to-day against smallpox. The soil will be kept enriched by plants which take their nutrition from the air and give fertility to the earth.

Black, Blue and Green Roses. Roses will be as large as cabbage heads. Violets will grow to the size of orchids. A pansy will be as large in diameter as a sunflower. A century ago the pansy measured but half an inch across its face. There will be black, blue and green roses. It will be possible to grow any flower in any color and to transfer the perfume of a scented flower to another which is odorless. Then may the pansy be given the perfume of the violet.

Few Drugs Will Be Swallowed or taken into the stomach unless needed for the direct treatment of that organ itself. Drugs needed by the lungs, for instance, will be applied directly to those organs through the skin and flesh. They will be carried with the electric current applied without pain to the outside skin of the body. Microscopes will lay bare the vital organs, through the living flesh, of men and animals. The living body will to all medical purposes be transparent. Not only will it be possible for a physician to actually see a living, throbbing heart inside the chest, but he will be able to magnify and photograph any part of it. This work will be done with rays of invisible light.

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"Man will see around the world."

Harold G. Shane & Gary A. Sojka, October, 1982, *The Futurist*, published by the World Future Society, 4916 St. Elmo Avenue, Washington, D.C. 20014. Reprinted with permission.

The 21st Century: Squinting Into The Crystal Ball

IF EVER A TIME WAS RIGHT for painting images of the future, it is now. The desire to know what will happen next year, next decade, next century seems insatiable.

Business executives want solid predictions on population shifts, changes in consumer tastes and government policies. Investors seek assurances that the economic climate in the years ahead won't jeopardize hard-earned cash. Workers agonize over whether their choice of career will be a gateway to golden opportunity or a dead-end street.

Even in leisure, adults and children alike seem obsessed with the future. Youngsters play with "Star Wars" toys and videogames with names like Asteroids and Space Invaders. Science-fiction books are among the hottest sellers.

For the serious-minded, too, the past year has produced a flurry of books peering into the 21st century with such titles as *Megatrends, Encounters With the Future, The Coming Boom* and *Change! Seventy-One Glimpses of the Future.* All describe a future that offers the potential for more economic prosperity, social progress and scientific advancement than the world has ever known.

To get a glimpse of the future as portrayed in these books, *U.S.News & World Report* talked with three of the authors: Writer and scientist Isaac Asimov, futurist Herman Kahn and forecaster Marvin Cetron. Below they outline, in brief, their visions of what lies ahead for the U.S.

Isaac Asimov

Author, *Change! Seventy-One Glimpses of the Future*

Fifty years from now, more of the world's surface may be used for farms, parkland and wilderness because we will be moving considerable quantities of industry into space.

Factories that make all sorts of chemicals might do well in space because there we have the opportunity to make use of environments that are not natural on earth. In space, we have a virtually infinite supply of vacuum—for free. We have hard radiation from the sun, and if we shield things well, we can get low temperatures without much effort. You also have gravity-free conditions, which improve methods for mixing. And in the absence of air you can have better welding and so on.

In addition, you have a perfectly enormous sink for waste products that can be used indefinitely without fear. Here on earth all the wastes that you use must go into the biosphere—that section of the earth's surface in which living things exist. In space, waste is diluted a millionfold because of the enormous void, and the solar wind would tend to sweep away pollution into the outer solar system.

Now, there wouldn't be many people actually working in these space factories. By the time we get factories into orbit, we're going to have them thoroughly automated and robotized. We will be able to run them from a distance with only occasional visits by technicians. Of course, we have to have a more or less steady stream of raw materials entering and finished product leaving, but I dare say that can be arranged, too.

As far as people living in space, that depends on when we make the decision to establish power stations in orbit that are capable of absorbing solar radiation and converting it to electricity to be sent to earth. It wouldn't be too efficient to have people working on such stations who had to constantly commute from earth, so there will be a strong tendency to develop large space stations where dozens of people will live for months at a time.

Ahead: "A planetary society in which all human beings have a stake"

Isaac Asimov

RICHARD KREPEL FOR USNEWS

If we start now, in 50 years I'd imagine we would have at least one of these stations in operation and a number of others being built.

I also look for the U.S., Russia and others to cooperate in such ventures because it would simply be too inefficient for countries to act on their own. The U.S. and the U.S.S.R. probably won't enjoy it, but I think that's the wave of the future: A planetary society in which all human beings have a stake.

On these space stations, people will spend their time building things, growing crops and tending animals. Others will supervise the activity of objects in space and run astronomical observatories and laboratories, or oversee the operation of mining stations on the moon.

It probably won't be until the 22nd century that these settlements are established enough to act as bases for further exploration into space. But the danger in such a prediction is that I'm too conservative, not sufficiently daring. Who would have imagined when the first airplane flew in 1903 that we would land on the moon 66 years later?

Herman Kahn

Author, *The Coming Boom*

The way I see it, the economic future of the U.S. looks mostly good over at least the next two decades. During that time, the country's gross national product should grow by an average of more than 3 percent each year, after adjusting for inflation. There are many reasons for this optimism: First of all, recovery from the current slump should be fairly sustained and strong because of cost cutting and better use of labor and equipment. Secondly, I see an end to the hostile and chaotic business environment of the last couple of decades. There will be less government regulation, an easing of inflation and a halt to escalating oil prices.

I expect enormous improvements in the labor force, which in the 1970s saw a big influx of women and young people. In the future, workers will be older, more experienced and better trained.

Eventually, too, you'll have revived investment in new plants and equipment that will make workers even more

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productive. Once recovery begins, "supply side" economics will help that process along because lower tax rates will stimulate greater savings and thus create the funds business needs to expand and modernize.

Then there are the sweeping changes in the makeup of our economy. Service industries will continue to grow along with the information revolution, brought on by advances in the computer, automation and related technologies.

"I'm not sure how well the U.S. will handle being rich and secure"

Herman Kahn

Almost equal in importance will be breakthroughs in biotechnology, the development of new materials, and new methods of protecting the environment and conserving energy. We'll have carbon fibers that are a third of the weight of steel but much stronger and more easily shaped, for use in autos, airplanes and other goods.

Food and agriculture are going to move right ahead with development of crops that can tolerate salt water or grow in the desert. Space technology will boom, as will medicine and health services. New developments in transportation will continue to be an important part of the economy. We will have a pollution-free car with a choice of perhaps 10 different fuels—the first and foremost being an electric battery.

With all these developments, per capita income in the U.S. will double in the next 20 years. By 2050, the U.S. will have 4 percent of the world population and 10 percent of the gross world product, as opposed to 5 percent of the world population now and about 22 percent of world GNP. It's inevitable that the rest of the world will catch up some. Still, the U.S. and Japan will be the richest countries in gross national product 50 years from now, followed by the U.S.S.R. or China, France or West Germany, Brazil and Mexico. All will be over a trillion dollars—1980 dollars—in gross product.

However, being wealthy can create some problems. As people get richer, they often become less competitive, less interested in creating a dynamic environment. I'm not sure how well the U.S. will handle being rich and secure, but I fear we will rest on our laurels. If we look at the 1960s, when such conditions prevailed, there was an enormous amount of turmoil. People took the system for granted and thought it could withstand anything. That could happen again early in the next century.

Marvin Cetron

Author, With Thomas O'Toole, *Encounters With the Future*

Many of the social changes we will see in the U.S. over the next 50 years are being pioneered in Sweden. As in that country, the gap between the rich and poor will shrink as a paternalistic government takes away more in taxes for such things as Social Security, subsidies for education and insurance against catastrophic illnesses.

On other social matters, fathers will take paternity leave along with mothers, and children will be able to choose which parent they want to live with after a divorce. More people will live together before marrying, and women will voluntarily have children out of wedlock just for the experience of it.

Longer life spans will mean more divorces. People won't put up with a mate they don't love for 60 or 70 years. As Margaret Mead used to predict, more people will marry three times: Once for love, once for children and once for companionship—though not necessarily in that order.

Such a matter as the equal-rights amendment won't even be an issue; it will be passed long before the year 2000, simply because older people who opposed it will have died off.

In careers, I expect more special college programs for bright students—whether these youngsters are needy or not. College will not be made available in the future for mediocre students because it will be too expensive. On the other hand, two-year community colleges with computers for job training will expand greatly.

"Who will determine whether to raise an IQ to 160?"

Marvin Cetron

Once people get in the labor force, they'll stay active and work longer. There will be all sorts of job shifting and job sharing.

In the next century, many people will change careers every 10 years. When you figure that in 75 percent of the cases both husband and wife will work, a family will be able to afford one of the spouses taking off to get retraining for the new job.

Because of great advances in computers and robots, the average work week will be just 20 hours shortly after the turn of the century, which will make leisure a huge industry.

In what will be a highly technical society, those who earn the most will be professional athletes, artists, writers, chefs and other creative people.

As always, people will debate moral issues, but there will be less willingness to let any group dictate rules and regulations. I look for more ecumenism in organized religion. One reason for that is the trend toward intermarriage among people of different faiths. At the present time, 40 percent of Catholics intermarry and about 33 percent of Jews do so, and the trend is increasing at the rate of 1 percent a year. Nothing forces people to take a more sensitive look at another faith than intermarriage.

Medical ethics will be a major social issue. In genetics, who will determine whether to raise an IQ to 160? Who will decide who gets certain wonder drugs—some 80-year-old Einstein or a 25-year-old woman with four children? It may take teams of professionals to answer such questions—not just a single doctor or clergyman. □

ACTIVITY 3

Predicting Your Own Future

At the beginning of this unit you read a scenario about life in the future. Will your life include work-at-home computers and robots as this episode suggests?

For this activity you will have to imagine that you are 70 years old. It is now the 21st century and you are looking back on your life. What was it like? What did you accomplish? What changes in the world did you observe?

Write a brief autobiography, from your perspective as a 70 year old, on the rest of this page (you may want to use additional paper, too). Be sure to describe how your lifestyle changed over the years. Apply the idea of a "Scotch Verdict" to each of your predictions.

THE GREAT TRANSITION

ONE VISION OF THE PAST, PRESENT, AND FUTURE

"Two hundred years ago, human beings were almost everywhere few, poor, and at the mercy of the forces of nature: one or two centuries from now, barring too much bad luck and bad management, they should be almost everywhere numerous, rich, and largely in control of the forces of nature."

The Next 200 Years: A Scenario for America and the World, Herman Kahn

Think about this statement for a moment. Ask yourself — what would my life have been like two hundred years ago? What would my main concerns have been? How would these concerns differ from what I am concerned about today or what I would be concerned about if I lived one hundred years from now? Ask yourself — how did my great grandparents and grandparents live?

Certainly, a lot has changed during the last two hundred years. Mankind has solved many problems and has created other problems too. But one thing is clear — much of what we take for granted today was only a dream to people living fifty years ago, let alone two hundred years ago. And, what seems miraculous to us now will likely be commonplace in one hundred years.

Getting the "Big Picture"

It is difficult to tell what a finished jigsaw puzzle will look like if you see only a few of the puzzle pieces. After you have put the pieces together, though, you are able to see the whole puzzle, or "big picture," and see the relationship among the individual pieces.

Historians also look for the big picture. They study what has happened in the past to better understand what is happening today and what might happen in the future. Looking at history over long periods of time is called *macro-history.* When people study history over long periods of time they are trying to get the big picture so that the present and future can be put in perspective. This "big picture" perspective allows us to see trends that influenced the past and that might continue to influence the future. Studying macro-history is one technique that futurists use to make predictions about the future.

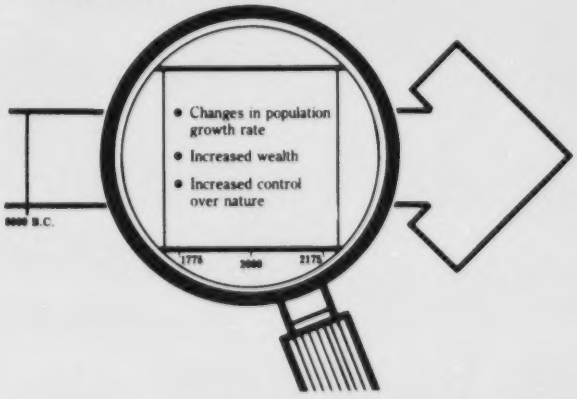
The Great Transition

In this unit a big picture of our history will be formed by looking at our past, our present, and our probable future. Facts and trends to aid us in forming ideas about what lies ahead will be presented. The big picture outlined in this unit is called the *Great Transition;* the quote that you read at the beginning of this unit describes this transition.

According to the concept of the Great Transition the U.S. and other developed nations are in the middle of a 300–400 year transition from a past when people were few and poor to a future in which they will be numerous and rich. This period of time is shown on the timeline on this page.

The Great Transition is a period of about 400 years, from approximately 1775 to 2175 (these are not exact dates when events began or will end). Underway for about 200 years now, the Great Transition should be completed by the United States and the other countries in the world in the next 100 to 200 years, if we can avoid too much bad luck or bad management. As you read about this transition keep in mind that different countries are at different points, or stages, in the development process. Some countries, like the United States, are very far along and other countries, like the "third world" countries in Africa, are not as far along. The major characteristics of this period of time are:

- Changes in population growth rate
- Increased wealth
- Increased control over nature



Another way to think about the Great Transition involves thinking about some specific changes during

this period of several hundred years. That is, during this transition people and their societies have changed or will change in these ways:

Toward the Beginning of The Great Transition	Toward the end of the Great Transition
Few	Many
Poor	Rich
Lore	Science
Illiterate	Literate
Primitive	Technological
Tribal	Bureaucratic
Local	Global
Chiefs/Kings	Administrators
Rural	Urban, Suburban, and Rural
Pre-Industrial	Post-Industrial

MAKING THE TRANSITION

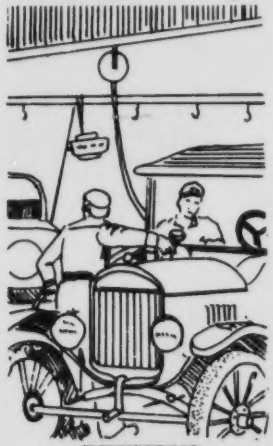
Societies go through the Great Transition via three stages of development:

Pre-Industrial Stage: In most preindustrial societies nearly everyone (90 percent or more of the population) work in activities such as agriculture, hunting, fishing, or mining. Most people have to do agricultural work so there will be enough food. Survival and protection from the forces of nature are the first orders of activity. Population grows very slowly. Very few people are considered wealthy.

The Bettman Archive

PRE-INDUSTRIAL

Industrial Stage: Most people work with machines to produce manufactured goods. Agriculture becomes so productive (because of technological improvement) that only a small percentage of the people are needed to produce food. Advances in health care and sanitation mean that people live longer and that population grows rapidly. Many people become wealthy through manufacturing, new inventions, and investments. Survival becomes much easier as the society develops many of the "comforts of home" as we know them today. Then in the "super industrial" aspect of an industrial society, technology becomes very sophisticated and the society is characterized by very large scale projects and rapid change.



INDUSTRIAL

Post-Industrial Stage: There will be a wide array of goods available in post-industrial societies, but not many workers will be needed to produce goods or food.* Instead of production tasks, most people will do work that provides services to other people. Post-industrial society will also have many jobs related to "high technologies," such as computers and telecommunications. These technologies will provide people

POST-INDUSTRIAL

*Since no society has become completely post-industrial yet, we cannot be 100% sure what this stage will be like. However, the descriptions of post-industrial society included in this booklet are Scotch Verdicts.

with increased leisure time, and surviving the forces of nature will be taken for granted. Population growth will slow dramatically and almost everyone will be wealthy when compared to the lifestyle that people had only 50 years before.

In the sections that follow, we will take a closer look at each of these stages in order to get the "big picture" of the Great Transition.

THE PRE-INDUSTRIAL STAGE OF THE GREAT TRANSITION

In pre-industrial society people rely mainly on natural resources for survival, and survival is an ever-present concern. This is a period of time when there are few machines available to produce goods. With a few exceptions, the countries in the world today have progressed beyond the pre-industrial stage of development.

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PRE-INDUSTRIAL

Slow Population Growth

Prior to 1800 (the approximate date when many countries began to industrialize), the world's population grew slowly. The average life expectancy was usually less then 35 years. Throughout the world, death rates were largely affected by wars, famines, plagues, floods and other natural accidents. These death rates were also high because of poor diet and lack of medical care, but the birthrate was slightly higher than the death rate. Generally, this meant that there were only slightly more births than deaths. As a result, the rate of population growth was slow — about one-tenth of one percent (the difference between 1,000 and 1,001 people) in an average year. Population grows slowly during a pre-industrial period.

Living Simply With Very Little Money

During a pre-industrial stage families rely on their members for survival; children are needed to provide labor to plant, harvest and prepare food, and to do other chores as well. Most pre-industrial people work in agriculture, hunting, fishing and forestry. These are considered to be "primary" activities because they must be done first if people are to survive.

A major characteristic of pre-industrial societies is that far more people live in rural areas than in cities; it is easier to engage in these primary activities in the country than in the city. For example, in the U.S. in 1800 only 160,000 people lived in the four largest cities combined! Most pre-industrial people lead very simple lives. Very few of these people are wealthy and almost everyone uses nearly all of their money to buy what is necessary for survival.

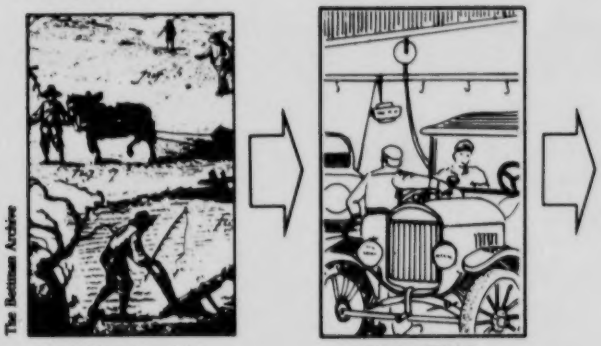
At The Mercy of the Forces of Nature

Pre-industrial people live poorly by our standards today. They are usually at the mercy of the forces of nature — storms and droughts create havoc, there are very few ways of storing food successfully for "lean" times, transportation is slow and often unreliable, medicine is a crude science at best and many people can die from plagues or even from simple colds. Life is pretty tough; many things that we consider necessities today (refrigerators, ball point pens, zippers, window screens, all those things which run on electricity) are unknown or unavailable in pre-industrial times.

THE INDUSTRIAL STAGE OF THE GREAT TRANSITION

Industrialization, sometimes called modernization, started in England and Holland in the mid-seventeen hundreds when goods increasingly began to be produced by machines. The term *Industrial Revolution* indicates that this change took place rapidly.

During the industrial stage of the Great Transition a society undergoes many dramatic changes. Many of the day-to-day problems of survival that pre-industrial people face are solved or eliminated as a result of industrialization; other problems are created. Some of the problems that the early stages of industrialization created include very long working hours, the harsh environment of work in the factories (these conditions were especially dangerous for child labor), mass pollution, and the displacement and dislocation of workers when machinery took their jobs. Nevertheless, people living in an industrial society seem to have it pretty good when you compare their lifestyles to the lifestyles of their pre-industrial forefathers.



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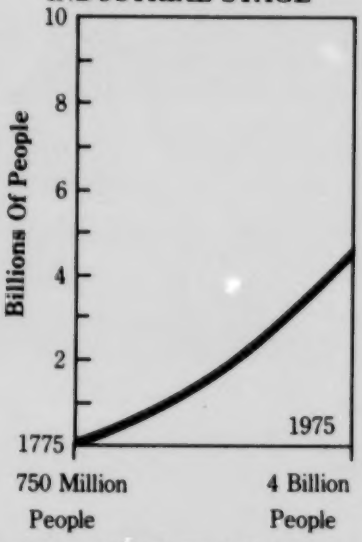
PRE-INDUSTRIAL INDUSTRIAL

Rapid Population Growth

About the time of the Industrial Revolution the rate of population growth started to increase very rapidly. Improvements in diet and medical care enabled people to live longer. These improvements were especially helpful for infants and young children. And, when people live longer (the death rate goes down), one result is rapid population growth. This is still occurring in some developing countries, and could cause serious problems in these countries as they move toward full industrialization.

If you describe population growth during the industrial stage by drawing it on a graph, it looks like a steeply increasing curve. Look at the chart below, which highlights the period from the Industrial Revolution to modern times, and you will see this rapid growth rate.

WORLD POPULATION GROWTH DURING THE INDUSTRIAL STAGE

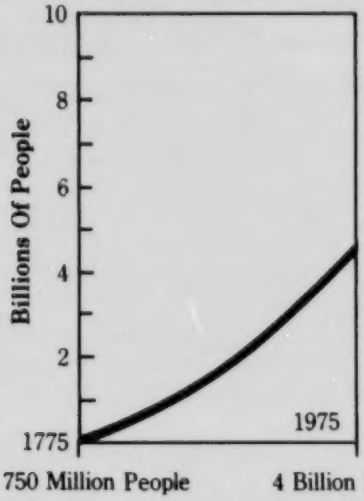


Source: Kahn, H. *World Economic Development*, Morrow Quill, New York, 1979, p. 66.

Until recently many people predicted that population growth would continue to increase at this fast rate. These predictions are frightening because they would seem to indicate that people could multiply until the Earth would not be able to support everyone. In fact, in the late eighteenth century an Englishman named Thomas Malthus predicted that the population growth rate would reverse itself when the world's population had grown to the point where there were too many people for the earth to support. He predicted that population would then decrease as a result of starvation, disease, and war. Different theories about population growth, like Malthus' theory, are based on different ideas about *rates* of growth.

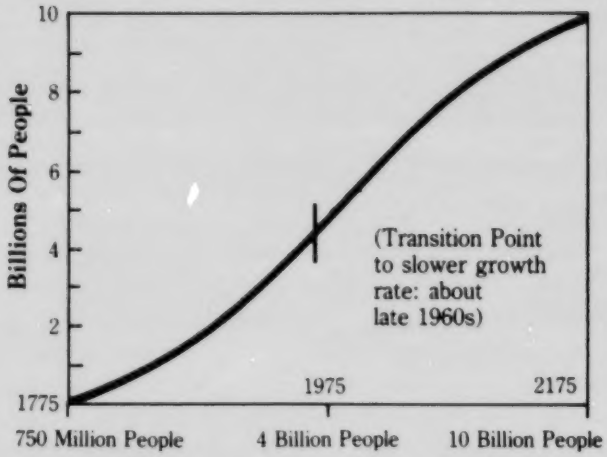
However, United Nations and other organizations studies have found that the growth rate for the world's population started to decrease in the late 1960s. Other studies indicate that industrializing countries have had decreasing growth rates for many years and that the population growth rates in many

WORLD POPULATION GROWTH DURING THE INDUSTRIAL STAGE



Source: Kahn, H. *World Economic Development*, Morrow Quill, New York, 1979, p. 66.

WORLD POPULATION GROWTH RATE DURING THE GREAT TRANSITION



Source: Kahn, H. *World Economic Development*, Morrow Quill, New York, 1979, p. 66.

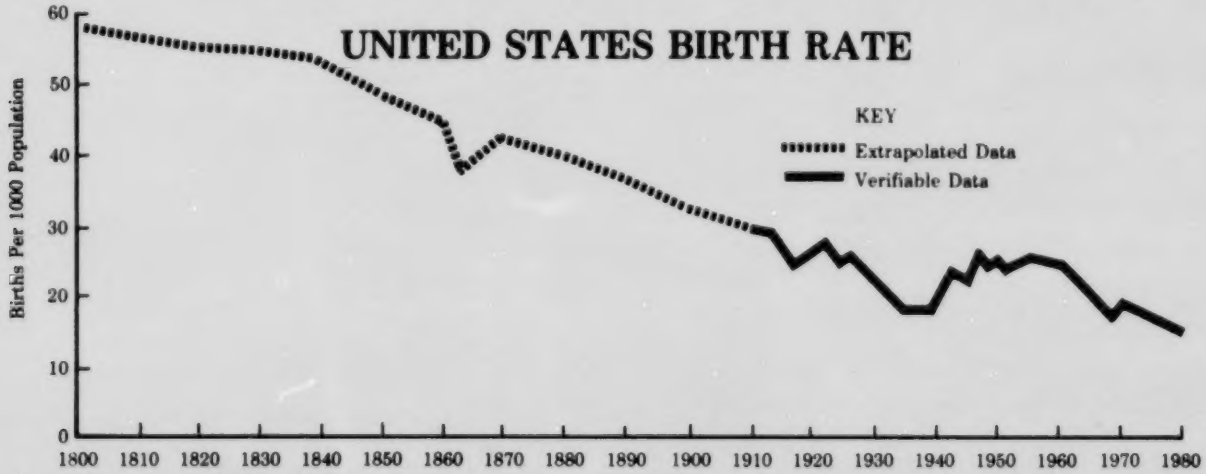
of the newly industrializing nations are also decreasing. According to a recent survey conducted for the United Nations, a typical family in the less-developed parts of the world (just beginning the industrial stage) is now smaller by one child than a typical family there ten years before.*

When the Population Reference Bureau reported this U.N. survey, it referred to the change of trend as "historic." If this trend continues, then the growth of population during the Great Transition will not create the catastrophic problems that some people, like Malthus, have predicted. It seems probable that this trend *will* continue since past experience shows that as societies become industrialized, literate, and urban, fewer children are born.

The charts above compare the population growth rate during the industrial stage with the population growth rate that is projected for the future. Both curves indicate that the *total number* of people will continue to grow, but not as rapidly as it once did. Since the world's growth rate *has* decreased, this means that the total number of people in the world is still increasing, but it is increasing more

*See, among others, *World Development Report*, World Bank, 1983 and *Demographic Indicators of Countries*, United Nations, 1982 for data related to each statement in this paragraph.

UNITED STATES BIRTH RATE



Source: *Historical Statistics of the U.S.: Colonial Times to the Present*, Part I, pp. 49–50.

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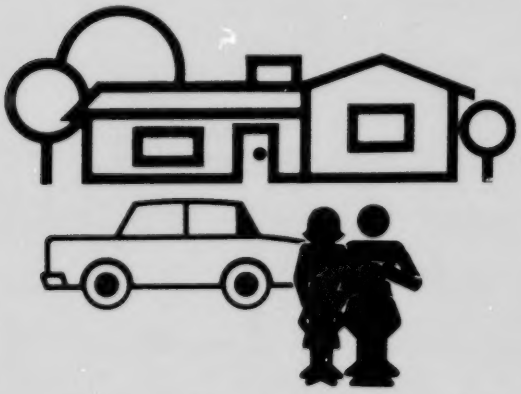
slowly than when the growth rate was higher.

As you study population growth and population growth rates, you should keep in mind that world statistics on population are sometimes considered to be crude estimates. Population data and estimates are revised frequently as new information becomes available. However, while exact population figures may vary depending on the source, growth (or decline) trends are usually agreed upon by the experts.

Demographers are people who study social statistics such as birth rates, death rates, and changes in population. These experts generally agree that the world population growth rate is declining and will continue to decline. They also point out that there is likely to be some short-term or isolated upturns of growth rate, like the U.S. "baby boom", but that these upturns will not substantially affect the overall trend toward a decline in the growth rate of the world's population.

Let's use the U.S. as a means of further studying

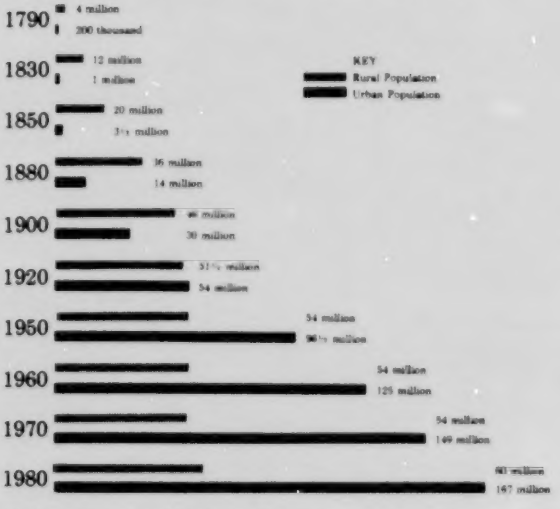


population growth rate during the industrial stage. As the chart on the previous page indicates, the birth rate was quite high during the Industrial Revolution, but it began to decrease over time. Why is this so?

There are many reasons why people decide to limit their family size. A major reason that families in industrial societies limit their size is that they have less need for their childrens' labor. A second reason is that people become used to smaller families. In the past, two or three children often slept in one bed, even in families that did not think of themselves as poor. Today most families do not experience this kind of crowding. A third reason is that effective technologies for limiting family size are now available (note that the U.S. birth rate dropped even before these technologies were available). Fourth, the costs of giving a child a good start in life have become much higher, as more and more jobs call for high school or college graduates. Fifth, many married women now decide to take jobs. This can make it very difficult to manage a large family. Sixth, raising children is expensive, so children actually *compete* with other ways of spending money. In short, children go from being producers of wealth in pre-industrial times to consumers of wealth in the industrial and post-industrial stages.

Most Americans still want children, but they typically want only two. Even at the height of the "baby boom" after World War II, the average family in the United States included only about three children. This was a far cry from 1800, when the average American family had seven or eight children.

UNITED STATES POPULATION SHIFT



Basic Data: *We the People*, Bidna, D., et al., D.C. Heath and Company, Lexington, MA, 1977.

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The Growth of Wealth

The major economic activities in the industrialization period shifted from primary activities, like agriculture, to "secondary" activities like construction and manufacturing. The largest surge in manufacturing during this period in the United States came from demands for guns, ammunition, uniforms and supplies as a result of the Civil War. After the war the growth of industry continued rapidly, especially in the northern United States.

The growth of industry was aided by the development of steam power to run trains, ships and machines. After 1870 steam power began to give way to electric power. By the early 1900's American factories were producing more goods than factories in any other country in the world.

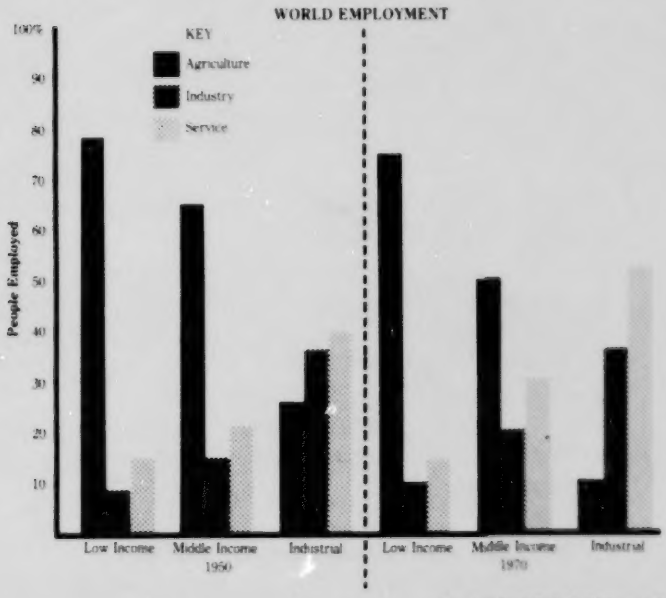
Accompanying these economic changes of the Industrial Revolution was the establishment of large urban areas (cities). Cities grew because of immigration and because many people who lived in agricultural areas moved to urban areas. This was possible because productivity in farming improved rapidly and because the development of canals, railroads, and other improved means of transportation enabled food and other essential goods to get to these urban areas.

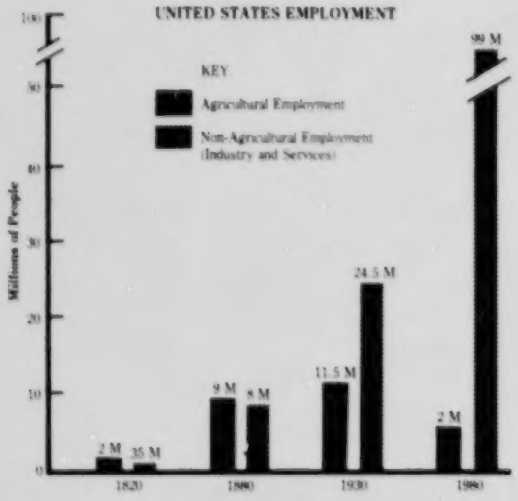
By 1930, only 30 percent of American workers earned their living by farming and at present only about 3 percent of our population does so. As new agricultural techniques increased farming productivity, fewer people had to live on farms to produce food. Increasing numbers of people moved to the cities and worked in manufacturing and construction. The cities provided new kinds of jobs and the chance to earn more money. In addition, people could see and do things in the cities that were not possible on farms in small communities. Today more than 75 percent of the people in the United States live in places with a population of 2,500 or more.

The chart on the previous page shows how the population in the United States has shifted from rural areas to urban areas during the last two hundred years. The chart also shows that there are more than 50 times as many Americans living today than there were in 1790.

Science and technology developed quickly during the Industrial Revolution. As industrialized countries improved their science and technology, more goods that people needed in their everyday lives were produced. These societies also produced goods that were needed by industry and conveniences that made life more enjoyable and made people more productive. A growing number of people became wealthy as a result of working for or investing in industry.

As industrialization grew, so did wealth. Today, middle class people living in North America, Europe and Japan generally enjoy standards of life that were





Basic Data: World Bank, World Economic Development Report, 1982; *Historical Statistics of U.S. Colonial Times to 1970*, U.S. Dept. of Commerce.

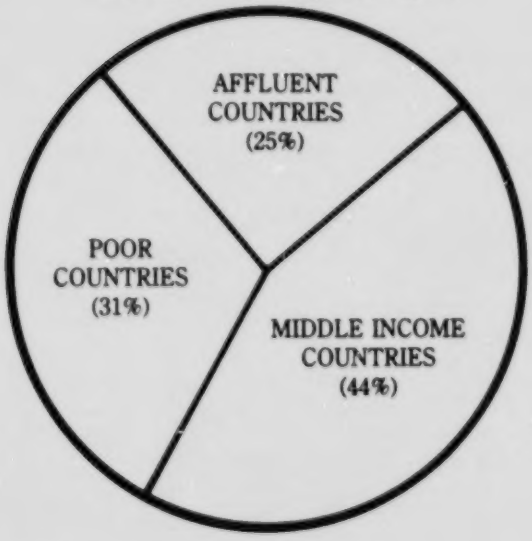
NEEDS

WANTS

unimagined even by rich people living 200 years ago. Even Americans who are poor by today's standards have better health care, transportation, and a higher standard of living than was enjoyed by rich people living only 200 years ago.

The increase in wealth that accompanies industrialization changes the perception of ***needs*** and ***wants***. ***Needs***, like food and shelter, are required for survival; ***wants*** are goods and services that people would like but don't need. Many things we consider to be "needs" in industrial societies today would have been "wants" and luxuries in the past. As wealth increases people focus more of their attention on wants.

POOR, MIDDLE INCOME, AND AFFLUENT COUNTRIES
Based on Per Capita Income



PER CAPITA INCOME:
POOR COUNTRIES — LESS THAN $350
MIDDLE INCOME COUNTRIES — $350–$3,000
AFFLUENT COUNTRIES — MORE THAN $3,000

Note: Calculated in 1977 dollars and 1977 data. U.S. per capita income was about $8,500.

Source: *World Development Report 1979*, The World Bank, Oxford University Press.

The United States and Western Europe began changing from pre-industrialized societies to industrial societies at the end of the 18th century (the late 1700's); Japan began industrialization around 1875. At some future time (probably in the next 200 years) most countries in the world will probably have experienced rapid change and development similiar to what we experienced during our own industrialization. Some countries, particularly in Africa, Asia, and Latin America, have only recently begun to develop industries and are still poor by our standards. However, these countries *have* begun the process of industrialization. This should lead them to many positive changes, and some problems too.

Since growth in wealth accompanies industrialization, important clues about the stage of development that a country is in are revealed when looking at the average income earned by people in that country. This is called ***per capita income***. A per capita income figure is obtained by totalling the values of all the goods and services produced in a country and dividing that sum by all the citizens in that country. This income figure may be lower than you might expect because everyone — all adults and children — is included.

The chart on the left divides the countries of the world into three basic groups according to their per capita income. As you look at these figures remember that there are some poor people in rich countries and some rich people in poor countries.

People in the United States are fortunate in many ways when our per capita income is compared with other countries. However, it is encouraging to

learn from this chart that the countries in which the majority of people in the world live are no longer defined as poor. This could not have been said fifty years ago.

You have probably heard the expression "The rich get richer and the poor get poorer." While this can be the case, many economists now feel that this does not really occur when they analyze worldwide economic development. As the world develops economically, this should mean that the rich get richer and the poor *also* get richer. One way to explain this idea is to use the analogy of a rising water level (economic growth) that floats ships (countries) regardless of whether they are large (affluent countries), medium sized (middle-income countries) or small (poor countries). In fact, this analogy was used by President Kennedy in a speech he gave on economic development. "A rising tide lifts *all* ships," he said.*

Of course, real life isn't exactly like this analogy. The growth rates of countries vary, with the fastest growth usually occurring in the middle-income countries. Even with worldwide economic growth some of the poorest countries may not improve very fast.

*Public remarks, Pueblo, Colorado, August 17, 1962.

POINT TO PONDER: Do you think the "rising level" theory will work? Who might not benefit? Why?

In general, since 1950 the world has changed from basically being made up of either rich or poor countries, with a small number of middle-income countries, to a world made up of largely middle-income and wealthy countries.

The differences in wealth between countries that began to industrialize 200 years ago and those that have not industrialized yet is very large. Many "have" countries average more than $8,000 per capita income. Many "have-not" countries average less than $350 per capita income. However, many of the "have-not" countries will benefit significantly from the fact that "have" countries exist. In fact, "have" countries are part of the reason that many countries today are industrializing so rapidly.

Even a poor country like India was able to develop during a 30-year period (between 1950 and 1980) most of the industries that the United States had in 1950. Yet, it took the United States over 150 years of industrialization prior to 1950 in order to achieve this level of industry.

As economic growth occurs, developing countries are able to learn from the experiences of countries that have already developed. For example, developing countries do not have to invent telephones, railroads, or computers; the more developed countries have already invested the time and money to create these inventions that are now available to all countries.

Developing countries can also avoid the mistakes made by earlier developers. They benefit from the existence of rich countries in other ways, too. The richer countries provide markets for their products; they provide shipping, jobs, university educations, and tourists for the poorer countries. Although the gains received by some countries during worldwide economic growth may be small, these gains can make the difference between meeting or not meeting their basic needs.

Let us suppose that the per capita income of rich nations averages $7,000 and the average for poor nations is $300. The difference is $6,700. According to this example, if the world economy doubled then the rich would average $14,000 per capita, the poor $600, and the difference would increase to $13,400. Some people might be very upset that the difference is now even greater than before. However, the people in the poor countries would have twice the income as before, which should improve their standard of living significantly. In fact, data shows that many poor countries increase their per capita income at a much higher rate of increase than rich countries do.*

POINT TO PONDER: Which do you think would matter more to people in poor countries, the rise in their standard of living or the widening difference between them and people in rich countries?

*Example:

Per Capita Income in U.S. Dollars

U.S.	Kenya
1970: $4851	1970: $143
1979: $10,777	1979: $394
Increase: $5926	Increase: $251
Rate of Increase: 122%	Rate of Increase: 176%

Source: *Yearbook of National Accounts Statistics, Volume II*, United Nations, 1980.

Middle income countries may seem poor by our standards, but by their own standards they have seen great improvements. The middle-income countries are the ones where economic growth has been most rapid in recent years. The affluent or rich countries have slowed to a lower economic growth rate and the poor countries have not yet reached the point of rapid economic growth.

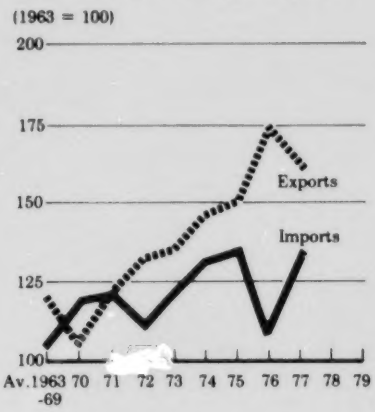
India is a good example of a once poor country that is improving its economic standing. The charts on the next page contain information on how India has improved. India is well on its way to industrializing and becoming a middle-income country.

Minimizing Problems With Nature

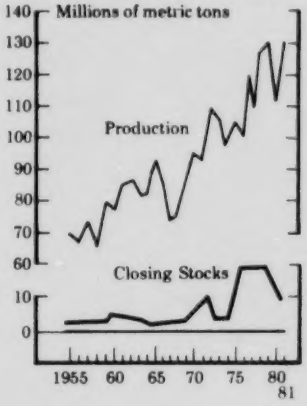
During pre-industrial times people were constantly at the mercy of the forces of nature. However, advances during the industrial period created a situation where people would be much less at the risk of these forces. Solid homes that people could afford were manufactured rapidly. Improvements in energy production, home heating and cooling and the development of modern types of insulation have assured many people of a "safe" place to live. Improved food storage techniques and methods of food distribution meant that food would be readily available, even in the event of a drought or other natural catastrophes. Medical discoveries meant longer and healthier lives. In sum, modernization during the industrial stage minimized the problems that mankind had with the forces of nature. And, while these forces still affect our lives, survival itself is not the day-to-day worry that it was during the pre-industrial stage.

INDIA

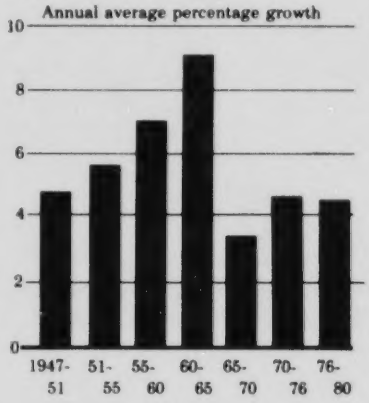
INDIA: EXPORT & IMPORT VOLUME



INDIA: FOODGRAIN PRODUCTION IMPORTS & STOCKS, 1955—81



INDIA: INDUSTRIAL PRODUCTION, 1947—80



India's production grew by an average 3.4 percent a year in 1964—73; it then increased to 4.3 percent a year in 1974—79, despite a sharp rise in oil prices. This large achievement was mostly a result of improvements in agriculture. In the past four years, India has imported hardly any foodgrains, and built its stocks higher than ever before. As a result India was able to manage the results of a severe drought in 1979 without major foodgrain imports.

Over the 1970s as a whole, foodgrain production rose at an average of almost 3 percent a year. Population grew only 2.2 percent a year. While the weather is still a major factor in Indian agriculture, the spread of irrigation and modern farming techniques has provided greater security. By almost ending foodgrain imports, India has saved large amounts of payments to other countries. This has helped it to pay for more expensive oil without limiting other imports.

Investments in industry have increased. Growth in industrial production is continuing. This growth was slower from 1965 to 1980 because not enough investment was made to improve and maintain coal mines, electric power plants, and railways. India is planning to increase investments in these areas in the 1980s.

Source: *World Development Report, 1981*, World Bank.

The Super-Industrial Stage of Industrial Society

The countries that have been industrializing for over a century can be considered to be undergoing a special stage of development called the "super-industrial stage." Many people living in super-industrial societies still work in manufacturing and other secondary activities, but "tertiary" (third level) jobs are available, too. Tertiary economic activities include jobs in service industries that support primary and secondary activities, like information processing, education, finance, and modern transportation. During the super-industrial stage the number of service jobs increases rapidly because industry in this advanced stage of development is very productive. Industry is now able to produce more than it did in the past with fewer workers.

The most important aspect of the super-industrial stage is the size (or scale) of projects. For instance, modern super-tankers that transport petroleum are cheaper and faster to operate than were older versions of these ships. However, because of their enormous size, if one of these modern tankers is damaged, then a tremendous amount of oil can spill into the ocean. The huge scale of many modern, super-industrial projects means that they are usually quite efficient, but they also run the risk of creating very large problems.

Another important aspect of the super-industrial stage is that during this stage information becomes a commodity. Knowledge and information become "big business" and more people can access more information than ever before. The availability of vast amounts of information, the ability to process it rapidly and efficiently, enable large scale projects to be created and maintained.

> POINT TO PONDER: What are some large scale problems that can occur when large scale projects are undertaken (e.g., 767 plane crash; power blackout; dam burst)?

A third aspect is that change occurs much more rapidly in the super-industrial stage of a society than it did at the beginning of industrialization. Alvin Toffler, a famous social scientist, called this change "future shock." Problems are certainly created by this rapid change, but many good things result from these changes, too.

An extremely important "project" of the super-industrial stage is the development of nuclear technology. The scale and impact on our lives of this project is enormous. The development of nuclear technology has made many useful things available to us in the areas of energy, transportation and medicine. However, this technology has also afforded the potential for nuclear war. Many of the promising things that the future holds in store would probably not be realized if a major war occurred in which nuclear weapons were used. Thus, when it comes to <u>all</u> large-scale projects of a super-industrial nature, good management is essential.

The super-industrial stage marks the beginning of the end of the industrial era for a society. If that society can avoid too many problems, it will eventually enter a post-industrial stage of development.

THE POST-INDUSTRIAL STAGE OF THE GREAT TRANSITION

What happens to a society after industrialization? When does the super-industrial stage of an industrial society end and the post-industrial stage begin?

There are no clear-cut answers to these questions, just as there is no way of identifying an *exact* date when the Industrial Revolution began. Instead, you should remember that the Great Transition is a concept — a way of looking at things that will give you a "big picture" perspective on historic changes.

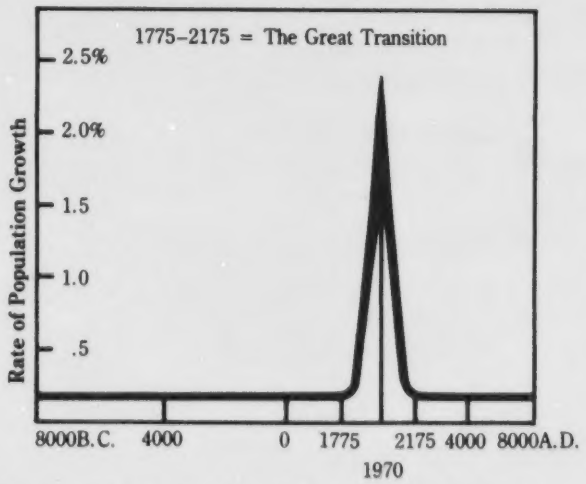
Think of it this way — pre-industrial society in the U.S. was the period of time before 1775; the industrial period began around this date; and after World War II, we moved toward developing the types of projects that are charactristic of the super-industrial stage; we are entering the post-industrial stage now. A post-industrial society, as you will soon read, is one view of what our future may be like.

The United States is the most economically and technologically advanced country in the world. It very probably will be one of the first countries to create a post-industrial society, and thus complete the Great Transition. As this new society evolves, many of the trends developed during the super-industrial stage will continue: projects will be very large scale; services will be readily available, efficient and sophisticated; people will have vastly increased leisure time and many new technologies will be created.

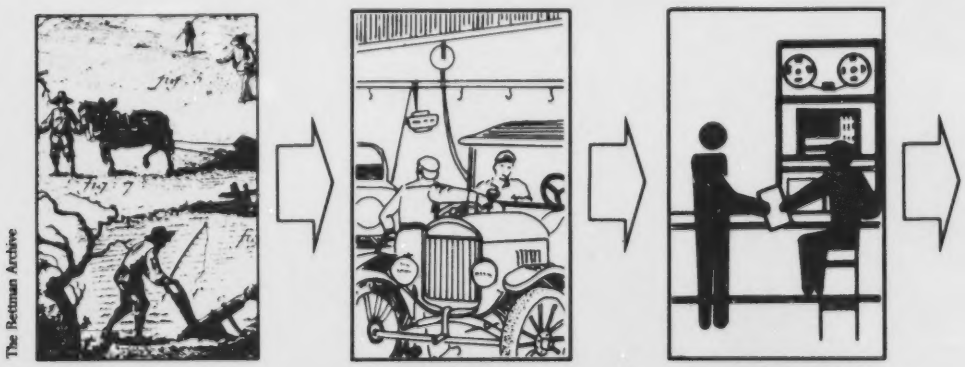
People Will Live Longer as Population Growth Slows

From what can be foreseen about our population growth, we should be able to have a somewhat optimistic view of the future. Most demographers expect the present decline in the world's birth rate to continue. In all the advanced industrial countries, population growth is now much slower than 20 years ago. As the charts on the next page show, many countries (this includes the United States) have had decreases in their annual rates of population growth during the past two decades. In fact, the U.S. birth rate has been decreasing since industrialization began.

POPULATION SPIKE CHART



Source: *Scientific American*, September 1974, pp. 36–37.



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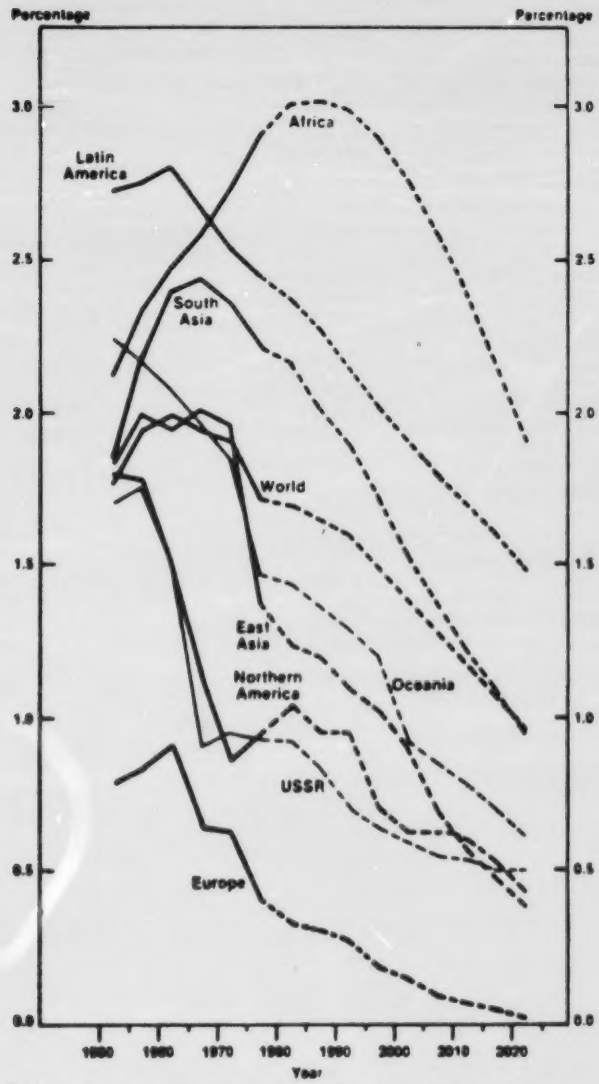
PRE-INDUSTRIAL INDUSTRIAL POST-INDUSTRIAL

42

AVERAGE ANNUAL RATES OF POPULATION GROWTH FOR MAJOR REGIONS OF THE WORLD, 1950–2025.



Source: *Demographic Indicators of Countries*, United Nations, 1982.

UNITED STATES BIRTH RATES

Date	Annual Births Per 1,000 People
1820	55
1880	40
1920	28
1932	20
1983	16

UNITED STATES DEATH RATES

Date	Annual Deaths Per 1,000 People
1875*	21
1900	17
1920	13
1983	8.5

*Massachusetts Only.

Basic Data: *Historical Statistics of the U.S.: Colonial Times to 1970*, U.S. Bureau of Census, U.S. Dept. of Commerce.

UNITED STATES AVERAGE LIFE EXPECTANCY (YEARS)

Date	Male	Female
1850*	38	41
1900	46	48
1920	54	55
1940	63	67
1983	71	78

*Massachusetts Only.

Basic Data: *Historical Statistics of the U.S.: Colonial Times to 1970*, U.S. Bureau of Census, U.S. Dept. of Commerce.

U.S. POPULATION WILL CHANGE

	1983	2033
Population	234,193,000	305,778,000
Population Growth Rate (per year)	.09%	0.1%
Median Age	31 years	41 years
Life Expectancy at Birth		
Men	71 years	74 years
Women	78 years	83 years

Source: U.S. Department of Commerce: Census Bureau Projections.

TRENDS IN BIRTH AND DEATH RATES

	BIRTH RATE (Per 1,000)			DEATH RATE (Per 1,000)		
	1960	1980	% Change	1960	1980	% Change
Low Income Countries	43	31	−28%	18	12	−36%
Middle Income Countries	43	35	−18%	17	11	−36%
Industrial Countries	20	15	−28%	10	9	−4%

Source: *World Development Report, 1982*, World Bank, pp. 150–151.

If You Live to Be 100—It Won't Be Unusual

Better health . . . more money . . . increased political power—tomorrow's elderly will be a dominant force in the U.S.

"Grow old along with me! The best is yet to be."

These words by poet Robert Browning will be truer in future decades than ever before as a more vigorous elderly population transforms America, once youth oriented, into a mature society.

In the next century, those 65 and over will account for more than 1 of every 5 persons and will alter the way the U.S. lives and works.

The elderly then will be active much longer as medical advances reduce illness and disability. By 2033, the Census Bureau expects life expectancy at birth to increase by about four years to 74.4 years for men and 82.7 years for women. But many scientists feel that those estimates could be far too conservative.

Aging slower. Dr. Roy Walford, a researcher at the medical school of the University of California at Los Angeles, says that discoveries in genetics and immunology will make it possible to slow the aging process itself, increase average life expectancy to 120 and extend the maximum life span to 150.

"People who are 70 will look as if they are 35," says Walford, "and people who are 100 will only look 50." If Walford is correct, America will change dramatically. Even those who do not share his optimism see major—though less drastic—changes ahead as the ranks of seniors are swelled by the aging of the baby-boom generation.

Over the next 50 years, the Census Bureau projects that the number of Americans 65 and over will more than double from 26.8 million today to 65.8 million people in 2033. As a result, programs designed for senior citizens could comprise as much as 65 percent of the federal budget, compared with almost 28 percent today.

More active physically and intellectually and better educated than earlier generations, tomorrow's elderly are likely to remain productive throughout their lives. Many will work at full or part-time jobs until they are well into their 70s.

Bernice Neugarten, professor of education and sociology at Northwestern University, sees society moving into an era of high technology in which "the wisdom, judgment and experience" of older people will be particularly valuable in the workplace.

A large number of senior citizens may well look back on two or even three careers as more Americans follow a pattern of combining leisure and education with employment at every stage of adult life. The concept of retirement age may even cease to exist.

Low birth rates, moreover, that reduce the number of work-force entrants will reinforce the need for people to work longer to keep the Social Security system afloat. Early in the next century, the eligibility age for Social Security will be pushed up, before the number of senior citizens begins to swell in 2010 when members of the baby-boom generation reach 65.

Robert Binstock, director of the Policy Center on Aging at Brandeis University, anticipates a more radical change: Abolition of Social Security and in its place a program to provide a minimum guaranteed income based on need, not chronological age.

In the marketplace, the burgeoning ranks of the elderly will require companies to pay more attention to older consumers as the need for baby carriages gives way to the demand for package tours, cosmetic aids and "On Golden Pond"-type romances on TV.

In politics, tomorrow's senior citizens—many of them veterans of activism in the 1960s—will exercise considerable power. Some forecasters even expect the voting age to be restored to the old minimum of 21. As these elderly activists battle the young for a bigger share of the American pie, a number of social scientists fear the possibility of intergenerational conflict.

Major concerns. Key issues over the next 50 years will involve housing and health care. Even with medical advances, a segment of the population, especially those over 85, will likely have disabling diseases.

With the ranks of people 85 and over expected to quadruple by 2033, the nation could find itself with a large dependent elderly population. "We will have a colossal problem," unless there are major advances in research on chronic diseases, warns Dr. Jacob Brody of the National Institute on Aging.

Not only is spending on medical care expected to expand dramatically, but health officials also worry about who will care for the chronically ill aged. With today's couples having smaller families or no offspring at all, there will be fewer adult children to look after ill parents, most of whom will be women as they continue to outlive men.

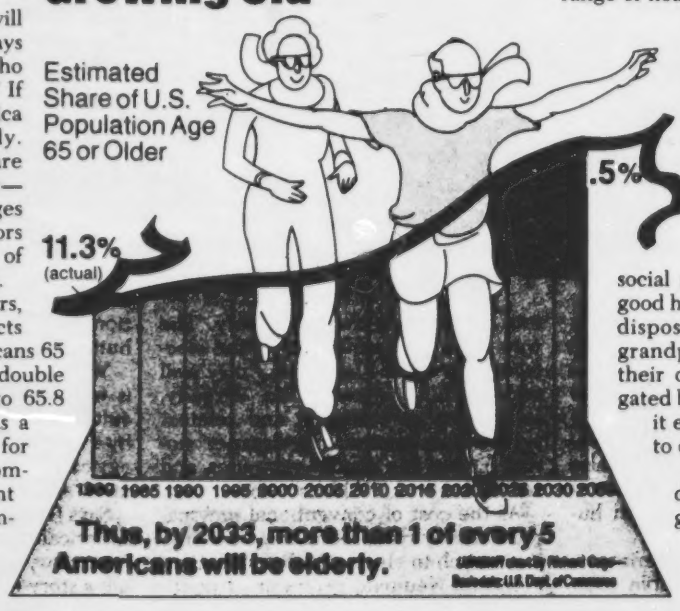
For a significant number of elderly people whose chronic ailments don't require institutional care, sociologists see the growth of "congregate" housing—apartment complexes offering a range of health and social services.

Many senior citizens will attend day-care centers. Says sociologist Jacquelyne Jackson of Duke University: "It can't be expected that children who were sent out to day care will care for their aged parents at home."

Most older people, social scientists stress, will be in good health. They will have more disposable income than their grandparents and will live on their own in housing not segregated by age as technology makes it easier for even the disabled to dwell wherever they want.

All in all, the U.S. will be drastically altered by the growth of an elderly population that will prove both a vital resource and a challenge. □

Growing Old


Estimated Share of U.S. Population Age 65 or Older
11.3% (actual)
.5%
1990 1995 1980 1985 2000 2005 2010 2015 2020 2025 2030 2035
Thus, by 2033, more than 1 of every 5 Americans will be elderly.

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You will recall that during the Great Transition, population growth rates have changed quite a bit. However, you must keep in mind that the Great Transition is but a 400-year period of time. Therefore, the period of the Great Transition is probably best portrayed as a *spike* in the overall population growth rate picture (the big picture of macrohistory). As the chart on page 36 shows, we seem to have reached the downhill side of the population spike. And, as industrialization occurs throughout the world and as post-industrial societies begin to develop, we can expect to see an ever decreasing population growth rate. Remember — this does *not* mean that there will be fewer and fewer people. Instead, it means that we expect to see very small increases in population in the 21st and 22nd centuries.

Overall world population growth rate peaked — to 2.4% annually — in the 1960's, according to the United Nations Population Bureau. Since then, it has declined to about 2%. Many experts feel that by the end of this century world population will grow at a 1.4% rate and that it will eventually (towards the end of the Great Transition) be well below 0.5%. This slowing of population growth reflects the increasing speed at which countries are industrializing.

Another interesting aspect of the post-industrial stage will be the amount of time that a person can expect to live. Life expectancy, as it is called, increases with modernization, while population growth rate decreases with modernization. So, while fewer people are being born, those who are born tend to live longer, healthier lives in an industrial and post-industrial society. The charts on page 37 illustrate this point.

Indeed, there will be more Americans in the next century than ever before, as the article on the previous page indicates. With people living longer lives, new problems will be created. Job markets in the fields of medicine and social care of the elderly will flourish. There will be more human services and human resources to provide these services.

The Riches of Post-Industrial Society

At the beginning of this unit you read that, during the Great Transition, people would go from being poor to being rich. Does this mean that everyone will have everything that money can buy? And, does this mean that there won't be any poor people? Actually, it means neither of these things.

As you recall, people living during the pre-industrial era had it pretty tough. They were not always sure that there would be enough food, that their houses would be hot enough or cool enough, or that they could survive even the most common sicknesses or foul weather. Happily, these worries are largely alleviated during industrialization, but many people still face enormous hardships during this stage of development. As more and more countries enter a post-industrial stage, these hardships should be reduced on a worldwide basis. No, the post-industrial era will not mean the end of all poverty or suffering; but, it will mean that fewer and fewer people will face these hardships. Being "rich" does not necessarily mean having lots of money. It's a relative term. If you are better-off than your parents or grandparents you might consider yourself "rich." Or, if you compare your lifestyle to that of pre-industrial people you might also consider yourself "rich." In many ways, being rich has less to do with money than it has to do with creating a healthy and safe lifestyle.

Three major economic factors will be at work during worldwide post-industrialization:

(1) the "rising tide" factor that you read about earlier,
(2) a greater interdependence among nations,
(3) the development of new technologies.

A rising worldwide economic "tide" should help many developing nations to make great gains in a relatively short period of time (remember the example of India?). As these developing nations prosper, they can, in turn, help other nations. And as developing nations become richer, job opportunities and the standard of living for people in those nations should improve. With economic development, these countries will be able to create the food, housing, and medical care that will enable their citizens to live like relatively rich people. However, in order for this to happen the leaders of these countries will have to decide to provide these opportunities, once their country begins to prosper. If the people in a country are going to become rich in comparison to their forefathers they will need good management and fair leadership.

A greater interdependence among nations during the post industrial era should encourage worldwide economic development, too. In this new era it will be hard for countries to be isolated. Advanced

forms of travel and communications will link nations. Each country is likely to have some things that another country wants. These things could be certain minerals, a labor force that wants work, or new information and technologies. Each of these things can be exchanged for money or traded for other items of value.

For example, the United States might create a new computer that Hong Kong wants. Hong Kong, on the other hand, may have a well trained and inexpensive labor force that U.S. business people require. These countries could then supply the other with what each has to offer. Obviously, this simple form of world trade goes on today. In the post-industrial world, more countries will have more to offer. This phenomenon will create more wealth and a greater distribution of that wealth worldwide. Indeed, this growth of wealth should reduce the so called "gap" between nations. Remember — the economies of developing countries can grow very rapidly as other countries enter the post-industrial stage.

The chart below shows how countries have developed and should develop in the coming years. As you read the chart, keep in mind that the *Gross National Product* (GNP) means the total estimated value of all goods *and* services produced in a country during a particular time period. As you can see from the chart, the economies of developing countries have grown very rapidly during the last twenty years compared with the already developed, or industrial, countries. These developing countries should continue to grow more rapidly, too. And, as this growth occurs, the economic differences between countries will diminish. While there are limits to this growth, these limits should not be reached until most people in the world have most of the things that — by today's standards — will make them "rich."

PERCENTAGE OF U.S. HOMES WITH CONVENIENCES

	1963	1983 (estimate)
Air Conditioner	15%	56%
Dishwasher	10%	46%
Clothes Washer	56%	78%
Blender	11%	53%
Television	91%	98%

AVERAGE TELEVISION VIEWING TIME PER DAY

1963	1983
311 Minutes (5 hours, 11 minutes)	419 Minutes (6 hours, 59 minutes)

Source: *U.S. News & World Report,* November 21, 1983, p. 79.

Even in the U.S., virtually the "richest" country in the world, standards continue to rise. Consider the charts above. These two charts show that people in our country are acquiring more things that make life convenient or save time. They also indicate that Americans have increasingly more leisure time — that is, they have to work fewer hours to acquire these conveniences. Americans will continue to enjoy the benefits associated with these trends, according to most experts who make economic predictions. And, if these trends continue, people in other parts of the world will enjoy these conveniences, too.

Are all these conveniences and all this leisure time good for people? Does it just make them lazy? And, does it create terrible jealousies between the relatively few people in this country, and relatively many people in the world, who don't presently enjoy these things? Or, will increased wealth in one part of the world continue to spread elsewhere like a rising tide? These are very tough questions to answer.

WORLDWIDE ECONOMIC GROWTH

(AVERAGE ANNUAL PERCENTAGE CHANGE)

Country Group	1960–73	1973–80	1980	1981	1982	Projections GNP 1980–1990 High	Low
Developing Countries:	5.8	4.6	4.0	2.2	3.9	5.7	4.5
Industrial Countries (Developed)	5.1	2.5	1.4	1.2	0.2	3.6	2.8

Source: *World Development Report, 1982,* World Bank, p. 8 and 37.

POINT TO PONDER: Some people feel that the wealth Americans enjoy is unfair and that we should do more for the rest of the world. Other people say that we already do too much for the rest of the world, such as giving foreign aid and sending food abroad. What do you think?

Advances in Technology Will Change Lifestyles

Pre-industrial societies had some very intelligent people who spent much of their time thinking about the world and its future. Some of their ideas were so accurate that even today people read about them. But pre-industrial people had little knowledge of what other people had discovered in other places and times. It was not until rather recently that a formal method of understanding nature's laws has been widely taught. The invention of the printing press allowed new ideas to reach many people so that research could be based upon what someone else had already found to be true.

The exciting thing about the growth of scientific knowledge and technology is that it builds on itself. Innovation does not stop when one invention has been perfected. Instead, one invention can inspire or enable people to create other inventions. Every new scientific idea and new technology increases the number of new ideas and technologies that can be discovered. During the post-industrial era, thousands and thousands of new technologies will be created and refined.

For instance, great progress was made when the technology of using animals to pull carts and carriages was developed. More new ideas and new technologies followed this development — "horseless carriages" powered by steam, electricity, and petroleum. Many engines are still measured in horsepower, but we have now advanced to airplanes, jets, and rockets. The speed at which people could travel has increased rapidly for the past 100 years and it should continue to increase during the post-industrial era.

The Computer: How a Technology Develops

The development of computers has followed a similar pattern — it is a good example of the scientific method at work. The history of the computer also illustrates how economic and social needs spur scientific and technological advances.

Nearly every student in the U.S. now has used a pocket computer, played a video game or commanded a computer terminal. And anytime someone dials a telephone, makes a bank deposit or orders a magazine susbscription, a computer goes to work. In fact, computers are such an important part of our everyday lives that many historians are already calling our era the "microelectronic revolution." With all of the computer-assisted devices in use today, it is sometimes difficult to remember that the technology allowing us to use microprocessors and computers as we do today really only developed during the past 40 years.

Back in 1946, University of Pennsylvania engineers switched on the first electronic digital computer. Its name was ENIAC, for Electronic Numerical Integrator and Computer. Using approximately 18,000 individual vacuum tubes, ENIAC could per-

THE SCIENTIFIC METHOD

The "scientific method" is a systematic, controlled way of conducting research. This method enables people to solve problems in a rational way. When the scientific method is used to study disease, for example, it usually gets results.

For thousands of years people suffered from a disease called malaria. After the development of the scientific method, scientists carefully observed who got sick. Since the people who got malaria had been outside at night, they formed a hypothesis that night air was the cause. They experimented by having people stay inside at night and close their windows and doors so night air could not come inside. Fewer people got sick, but some still got malaria. Further hypotheses and experiments finally proved that mosquitoes carried the disease. The first control was to avoid mosquito bites. Then more research showed ways of reducing the number of mosquitoes. Malaria affects far fewer people today than it did a hundred years ago.

form up to 5,000 calculations each second. Unfortunately, our first electronic computer also filled a room as big as a three bedroom house, and it devoured enough electricity to light up a small town.

Today the same amount of computation can be performed by a couple of peanut-sized silicon chips wired into a shirt pocket calculator powered by a single nine volt battery.

Since the unveiling of ENIAC, computer technology has advanced so quickly that the amount of information a computer can handle has grown exponentially — just about doubling every two years during the last three decades. Consequently, modern "supercomputers" now perform millions of computations per second.

How did computer technology make such giant strides? To answer that question, let's glance backwards a moment. Some 150 years ago, British inventor Charles Babbage detailed plans for the first "calculating engine" which used holes punched in cards to help store information. Half a century later, the U.S. Census Bureau used this design to process population statistics. Then, another half a century went by before ENIAC incorporated electronics, vacuum tubes and the binary code to speed up calculating.

The binary code, which marked a major advance in machine calculating, represented all numbers as one of only two digits, either "one" or "zero." This system allowed machines to read any number as a series of electric currents that switched either "on" (for number one) or "off" (for number zero). The binary code greatly simplified information storage and retrieval.

Shortly after ENIAC, in 1947–48, Bell Laboratories developed the first transistor. Made from silicon chips, the transistor replaced large, hot, power hungry vacuum tubes and tremendously reduced the size of computers.

But even transistors still needed a lot of bulky wiring to tie individual components together. So when scientists at Texas Instruments Corporation and Fairchild Corporation developed a way to wire transistors together on a single chip of silicon — making the first "integrated circuit" — miniaturization took off once again.

By 1971 electronics companies managed to squeeze all of a computer's central processing components and circuitry onto a single "chip." They dubbed this new kind of chip a microprocessor, because it could be programmed just like any other computer core. These new chips were so potentially powerful that, even in the beginning, a single microprocessor only a quarter of an inch across could outcompute the huge ENIAC machine.

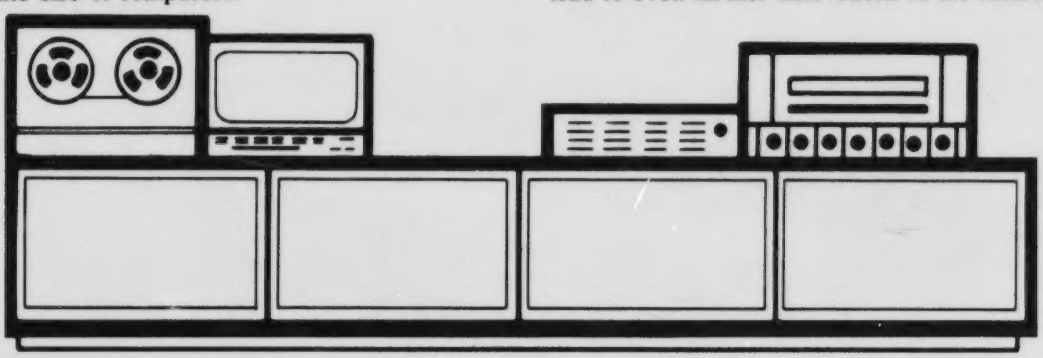
Now, millions of electronic components can be etched onto a single tiny chip. This means that potent central processing units which previously cost thousands of dollars can be mass produced today for under $10. Advances in technology often tend to deflate prices.

Modern microprocessors are so cheap and reliable that they are common to almost every walk of life. They guide sophisticated fighter planes and missiles, speed long distance calls, increase an automobile's fuel economy, change cycles in washing machines, and entertain with video games and toys.

Once a new technology is developed for a specific need, it can also be applied to different uses — even video games. So long as people are interested in new ideas, science and technology will continue to cause change.

Space: How the Development of One Technology Leads to Another

Space is yet another example of how innovation in technology during the super-industrial stage will lead to even further innovations in the future. Foot-



prints on the moon. Shuttle trips to orbiting space stations. Satellite explorations of Mars, Jupiter, Saturn and other solar systems. These are some of the things most of us think about when we consider space travel and the U.S. space program.

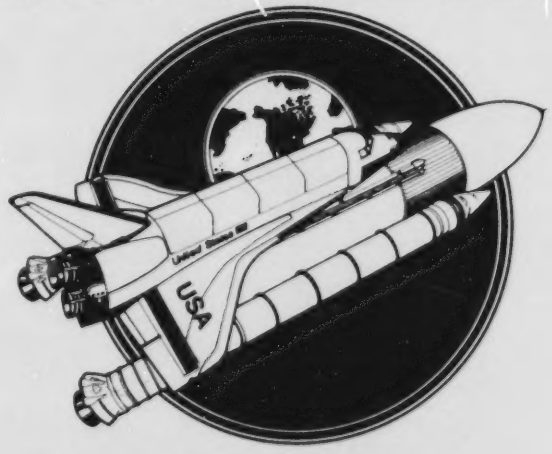
Most people, however, don't realize the many down-to-earth uses we have found for exotic space technology. NASA officials call these alternative uses for space technology "spinoffs."

Space program spinoffs have made improvements in many different fields, from medicine to firefighting to . . . well, sewers. Following are some applications of just a few spinoffs.

- Surgeons need lightweight, powerful, portable precision power tools for use in the operating room. Astronauts had the same requirements for tools used to drill rocks on the moon. As a result, special battery operated motors designed for astronauts were quickly adapted to power surgical tools. Now surgeons can efficiently and precisely drill skulls for brain surgery, cut bones to rebuild damaged legs, and perform many other operations with greater skill and success.
- Cataracts can cause blindness if they are not detected and removed. The problem is in "finding" a cataract deep in a victim's retina inside the eye before it can cause severe damage. Space program development of "computer enhanced" aerial photos have made it possible to take photographs of the retina, then later "enhance" the image to expose any irregularities that may lead to future cataracts.
- At least two space spinoffs promise safer firefighting. One application uses a small, lightweight rocket engine pump to shoot water 400 feet away, at a rate of 50 gallons per second. Because the pump is relatively small, it can be hauled easily in a pickup truck, or quickly airlifted to a remote scene by helicopter. Another spinoff brought materials developed for space suits into use for firefighters' "turnout gear." The result is a fire suit that keeps cooler, lasts longer and weighs half as much as the old gear. These improvements should reduce the incidence of heat exhaustion among firefighters in critical situations. Also related to this spinoff from space suits, NASA scientists helped build an "earthsuit" for a boy afflicted with severe allergies to grass, trees and unfiltered air. The protective suit allowed him to go outside safely for the first time in his life.
- As much as we try to forget about it, the fact is that sewage must be monitored constantly so treatment plants don't overflow. Space technologies employed for space projects such as the Apollo missiles, satellite sensors, and in other areas of the space program contributed to the development of an in-sewer scanner that can deliver immediate, accurate flow information to plant operators sitting clean and dry in their offices miles away.

Besides the applications mentioned above, space spinoffs are now being used or tested to improve the food we eat and the way we grow it; to help diabetics and patients of colon surgery; to design safer, faster ships; to help hang gliders fly; to clean up oil spills; and to test earthquake resistant building designs. These are just some of the exciting new technologies that are likely to be developed during the post-industrial era. Even if you never get to fly through space, you will probably reap the benefits of space travel through spinoffs.

Indeed, there will continue to be incredible advances in technology during your lifetime and on into the post-industrial era. These advances will change your lifestyle and will affect people throughout the world. People will be healthier due to advances in medical technology, they will get places quicker and more safely due to advances in transportation (although we also know that increasing speed has corresponding risk). Time-saving devices will likewise



create more leisure time. Through scenarios and examples, some of the areas where we expect tremendous advances in technology are discussed on the pages that follow. As you can imagine, this discussion could be much longer.

Other Emerging Technologies

Chips and Computers

Imagine waking up in the cool darkness of the predawn hours. Before tossing off your covers and jumping out of bed, you say two distinct words — "light" and "heat." Immediately a lamp in the corner switches on and warm air from your central furnace pours into the room.

After shower and breakfast, you walk out the door. It clicks shut and locks behind you. Suddenly you remember your wallet — you left it on the table. You turn back to the front door and say your personal password, maybe something like, "Open sesame." The door unlocks, you go in and quickly retrieve your wallet.

Walking out to your car, you remove a credit card-size piece of plastic from your wallet. You place it in a slot in the door and it opens. Next, you place the same card in the ignition slot. Your car roars to life and you drive off.

You have just imagined two of the emerging technologies that are almost ready for consumers: voice responsive ("hearing") computers and "smart" cards incorporating microprocessor chips embedded in plastic.

Voice responsive computers can now react to certain verbal signals and distinguish between different voices. When perfected, they will be able to compare a given audible command with an individual "voice print" which identifies a single authorized user. If the command voice matches the voice print, the computer will carry out its orders, performing such tasks as opening locked doors, or revealing private information.

Smart cards are also being tested for business and financial uses. When placed in an appropriate slot, a smart card's computer chip communicates with another chip built inside the slot. When used as a bank card, the tiny chips could be updated automatically every time it is used to withdraw money or make a purchase. Used as keys, they can unlock doors or turn on equipment.

Hotels are particularly interested in smart card keys because the cards could be reprogrammed after every night's use. That way hotel guests can have greater room security without requiring hotel personnel to make costly lock changes for every new tenant.

Other uses for smart cards may include pay telephones, gasoline pumps, vending machines, and mass transit fares.

Robots

Visit a factory of the future and you may see humans and robots working together. On many assembly lines, robots are already taking over certain jobs. Starting with the most dangerous tasks such as deep rock mining and the handling of radioactive materials, robots may soon perform almost all tedious and repetitious jobs. Japanese and American carmakers have employed robot welders, painters, and assemblers for years in order to assure quality control. They report that robots work longer hours, take no vacations or coffee breaks, cost less and make fewer mistakes than humans. The use of robots will steadily increase in the years to come.

Lasers

The continuing development of lasers — intensely focused beams of light — has opened many exciting new fields. In medicine, lasers have been used for extremely delicate surgery, particularly on the eye. In industry, lasers help robots "see," and carry information similar to radio signals. The military is designing laser weapons that can knock down an attacking missile or disable a tank.

In the entertainment industry, lasers have been used to replace stylus needles on video disc players. A laser stylus is preferred because it causes no wear on the disc, plus it can easily "freeze frame" a video image, or play in reverse without causing disc damage.

Photonics

Lasers and computers have joined forces with the new fiber optics industry to improve communications, especially by telephone. Scientists call the new communications system "photonics." In a photonics device, integrated optical circuits — miniature lasers built into micro chips — send pulses of light over hair-thin glass fibers. Tiny photonics components will someday replace existing wire systems at a lower cost. As an added benefit, scientists predict

that photonics systems will soon be able to carry information at a thousand times the rate of the wire system we now use.

Some experts believe that communication is only the first application for photonics. They predict that photonics may soon replace traditional silicon chips in computers. The advantage for computers is that photonic components can react at the speed of light, instead of the somewhat slower rate at which electricity travels through a silicon chip. Photonic development could introduce a whole new age of optical computers that far outpace our fastest electronic models of today.

Bioengineering

Picture a farm that raises medicine as its cash crop. Instead of a location on acres of rural countryside, this farm exists inside a huge laboratory building in the industrial section of a major city. And the crop of medicine is harvested every day from a vat of genetically altered bacteria.

Sound intriguing? That kind of "medicine farm" is exactly what genetic researchers plan to introduce as a result of some experimental bioengineering work done today. Using a technique called "gene splicing," or recombinant DNA, scientists have created bacteria that routinely manufacture insulin, a medicine vital to diabetics, and interferon, a promising cure for viral cancer and other viral diseases. Gene splicing has also produced bacteria that make a human growth hormone to treat dwarfism (a genetic disease that retards human development to a level far below ordinary size); and scientists look forward to the challenge of synthesizing new strains that will provide vaccines against common diseases such as measles or smallpox.

The reason for all the excitment surrounding bacteria medicines is that raising bacteria requires little food in order to produce relatively large amounts of medicine. Rare medicines that by conventional methods presently cost hundreds of dollars per gram to produce, may someday be manufactured by bacteria for only pennies.

Telecommunications

Giant shopping malls of today may become the dinosaurs of the 21st century. At least some experts in telecommunications believe that shopping malls will become "extinct" as new forms of cable television make shopping from home faster and more convenient than driving to the store, especially in bad weather.

Present cable TV systems allow store retailers to catalogue their merchandise on special channels viewed on ordinary television sets. With the advent of home computer linkups, shoppers could "call up" specific items on their television, check size and price, and merely press a button that sends the order to their homes. Special bank identification codes would automatically charge the buyer's account for each item purchased.

Cable television and computers may provide other innovations for the future. One idea, developed under the name Teletext, has been pioneered in England and introduced to some parts of the U.S.

Teletext broadcasts news, photographs, and advertising to the home via cable TV hookups. It brings newspaper information to every household at a mere fraction of the cost of printing a daily paper. And, unlike newspapers, Teletext can be updated throughout the day to follow breaking news events. Many experts expect systems like Teletext to supplant newspapers in the near future, particularly in the lucrative area of classified advertising.

Cable television may also be able to provide politicians with instant feedback on important social issues. Imagine a major speech by the president broadcast over cable television. Viewers at home could immediately respond to the speech using their computer keyboard. Positive and negative reactions would be instantly tabulated by computer, giving politicians a valuable poll of their voters. Similar systems provide remote access to library research, educational lessons in math or language, and a wide variety of video games and puzzles.

Space

A recent poll showed many Americans look forward to a chance to rocket into space. The U.S. Space Shuttle may soon provide that chance. At the same time, the shuttle will be able to do much, much more.

The shuttle can carry passengers, launch satellites into orbit, truck materials and workers out to space stations, and allow scientists to perform experiments requiring the extreme cold or vacuum of space. Already, some tests have shown great hope for certain drug refining operations that seem to work much more efficiently at zero gravity. Orbiting space stations supplied by the shuttle might someday produce these

products in mass quantities. Space laboratory workers, then, would probably become space "commuters," catching a ride to work via the space shuttle!

Agronomy

Of course, orbiting laboratory workers will have to eat something while they're at the lab. But hauling every bit of food into space might prove too costly. So agronomy researchers are now solving the problems posed by growing food in space.

These researchers have improved methods for growing food crops under zero gravity, in cramped quarters and with no soil — conditions one might expect in space. Not only does this work benefit space stations, but the same techniques are also being adapted to help farmers in desert and arctic countries where soil or growing conditions are too poor for traditional planting techniques. These new techniques will lead to the production of more food from less land and will enable us to continue to be able to dramatically increase food supply.

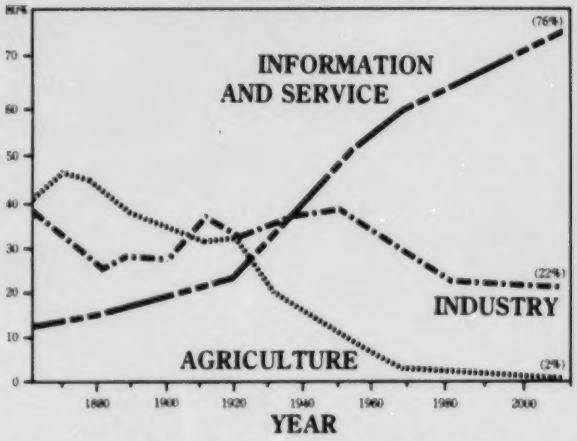
RAPIDLY DEVELOPING TECHNOLOGIES*

1. Inexhaustible and/or inexpensive energy sources.
2. "Pollution-free" industries and transportation.
3. Telecommunications.
4. "Unconventional" agriculture and artificial foods.
5. Materials: fibers, foams, ceramics, crystals, adhesives, composites.
6. Human-machine communications.
7. Bio-engineering.
8. Space travel and manufacturing in space.
9. Robots and other automation devices.
10. Computers.
11. Medicine: diagnostics, treatments, surgery & pharmaceuticals.

Basic Source: Hudson Institute, National Research Council.
**Not* listed in relative order of how fast they will develop.

All of these advances will affect your lifestyle. They also are helpful in pointing out what type of work force will be needed in the future. This will be discussed more in the last unit of this booklet. And, as you recall, these advances will lead to more "tertiary" economic activities, such as jobs in service and information areas; at the same time they will decrease the need for people in agriculture and manufacturing.

U.S. LABOR FORCE



Sources: U.S. Office of Telecommunications, *The Futurist,* and additional extrapolation by author.

Will science and technology really grow so fast? No one knows for sure, but we can at least say that we have a Scotch Verdict on this issue. The number of scientists and engineers we produce, and the percentage of our income that is spent on research may stop growing. Though this might slow the rate of new discoveries, it is not likely to stop it. It is more likely that, as in the past, new discoveries will prompt other new discoveries. And, each discovery will in turn have some effect on lifestyle. Some of these effects will be positive and others may not be so positive. Some people think that technology "dehumanizes" people, while others argue that advances in technology create enormous benefits for everyone.

Our current understanding of the laws of physics leads us to believe that limits will be reached in each field someday. For instance, the famous scientist Albert Einstein theorized that nothing could go faster than the speed of light because of the laws of nature. If this is so, increasing travel speeds would eventually reach their limit as the speed of light was approached. In other words, Einstein suggested that people would not be able to travel faster than the speed of light.

But we can never be sure that the limits we know today won't be expanded by new knowledge or new technology. What we think is a limit might merely be the result of our inability to see beyond it. Most scientists seldom use the word "impossible." They are more likely to have an attitude like that of the wise person who once said that "it is good mental exercise to believe at least one impossible thing before breakfast each day!"

SUMMARY

Studying the "Great Transition" cannot give us a total vision of the future. This concept describes certain things that have happened for the past 200 years and we can use this information to predict some things that might happen in the next 200 years. Of course, we can't be 100% sure of what will happen in the future. However, by studying the trends and big pictures of the past and present we may reach a Scotch Verdict on what will probably occur.

ACTIVITIES: THE GREAT TRANSITION

ACTIVITY 4

THE GREAT TRANSITION

In every country, three changes occur during the transition from a pre-industrialized economy to industrialization. These changes are described in your text. If you don't recall the changes, take a few moments to review them. Then, write each type of change below.

- Change 1: _____
- Change 2: _____
- Change 3: _____

How big are these changes? Use the graphs and tables to make the following comparisons of the United States before and after industrialization.

	Pre-Industrialized U.S. (1850)	**Industrialized U.S. (1950)**
Number of people (Chart 1)		
Number of people living in cities (Charts 2-A and 2-B)		
Number of people living in rural areas (Charts 2-A and 2-B)		
Number in labor force working in manufacturing (Chart 3)		
Number in labor force in agriculture (Chart 3)		
Gross National Product (Chart 4)	1869: $_____billion	$_____billion
Infant mortality rate (for example in Massachusetts) (Chart 5)	_____per 1,000 live births	_____per 1,000 live births
Life expectancy at birth (for example in Massachusetts) (Chart 6)	_____years	_____years

Chart 1

NOTE: Make sure to add the numbers in both the male and female columns to determine total population.

POPULATION

Series A 91–104. Population, by Sex and Race: 1790 to 1970

Year	Male							Female						
	All races	White	Negro [1]	Other races				All races	White	Negro [1]	Other races			
				Total [1]	Indian	Japanese	Chinese				Total [1]	Indian	Japanese	Chinese
	91	92	93	94	95	96	97	98	99	100	101	102	103	104
1970 [2]	98,912,192	86,720,987	10,748,816	1,442,389	388,691	271,300	228,565	104,299,734	91,027,988	11,831,973	1,439,773	404,089	319,990	206,497
1960 [3]	88,331,494	78,867,149	9,118,408	850,937	263,369	224,828	135,549	90,991,681	80,464,583	9,758,423	768,676	260,222	239,504	101,743
1950	74,833,239	67,129,192	7,296,722	405,825	178,824	76,649	77,008	75,864,122	67,812,836	7,743,544	307,722	164,586	65,119	40,621
1940	66,061,592	59,448,548	6,269,088	344,006	171,427	71,967	57,389	65,607,683	58,766,322	6,596,480	244,881	162,542	54,980	20,115
1930	62,137,080	55,922,528	5,855,669	358,883	170,350	81,771	59,802	60,637,966	54,364,212	6,035,474	238,280	162,047	57,063	15,188
1920	53,900,431	48,430,655	5,209,436	260,340	125,068	72,707	53,891	51,810,189	46,390,260	5,253,695	166,234	119,369	38,303	7,748
1910	47,332,277	42,178,245	4,885,881	268,151	135,133	63,070	66,856	44,639,989	39,553,712	4,941,882	144,395	130,550	9,087	4,675
1900	38,816,448	34,201,735	4,386,547	228,166	119,484	23,341	85,341	37,178,127	32,607,461	4,447,447	123,219	117,712	985	4,522
1890	32,237,101	28,270,379	3,735,603	231,119	125,719	1,780	103,620	30,710,618	26,830,879	3,753,073	126,661	122,534	259	3,868
1880	25,518,820	22,130,900	3,253,115	134,805	33,985	134	100,686	24,636,963	21,272,070	3,327,678	37,215	32,422	14	4,779
1870 [4]	19,493,565	17,029,088	2,393,263	71,214	12,534	47	58,633	19,064,806	16,560,289	2,486,746	17,771	13,197	8	4,566
1860	16,085,204	13,811,387	2,216,744	57,073	23,924	.....	33,149	15,358,117	13,111,150	2,225,086	21,881	20,097	.....	1,784
1850	11,837,660	10,026,402	1,811,258	.....	.....	.....	.....	11,354,216	9,526,666	1,827,550	.....	.....	.....	.....
1840	8,688,532	7,255,544	1,432,988	.....	.....	.....	.....	8,380,921	6,940,261	1,440,660	.....	.....	.....	.....
1830	6,532,489	5,366,213	1,166,276	.....	.....	.....	.....	6,333,531	5,171,165	1,162,366	.....	.....	.....	.....
1820	4,896,605	3,996,809	900,796	.....	.....	.....	.....	4,741,848	3,870,988	870,860	.....	.....	.....	.....
1810	(5)	2,968,130	(5)	.....	.....	.....	.....	(5)	2,878,943	(5)	.....	.....	.....	.....
1800	(5)	2,195,305	(5)	.....	.....	.....	.....	(5)	2,111,141	(5)	.....	.....	.....	.....
1790	(5)	1,615,434	(5)	.....	.....	.....	.....	(5)	1,556,572	(5)	.....	.....	.....	.....

Chart 2-A

Shown in "Thousands." *3,544* in this table means *3,544,000* (1000 x 3,544).

A 57–81

POPULATION

Series A 57–72. Population in Urban and Rural Territory, by Size of Place: 1790 to 1970—Con.

[In thousands]

Series No.	Class and population size	1890	1880	1870 [1]	1860	1850 [1]	1840 [1]	1830	1820	1810	1800	1790
57	Urban territory	22,106	14,130	9,902	6,217	3,544	1,845	1,127	693	525	322	202
58	Places of 1,000,000 or more	3,662	1,206	.....	.....	.....	.....	.....	.....	.....	.....	.....
59	Places of 500,000–999,999	806	1,917	1,616	1,279	616	.....	.....	.....	.....	.....	.....
60	Places of 250,000–499,999	2,443	1,801	1,524	267	–	313	.....	.....	.....	.....	.....
61	Places of 100,000–249,999	2,782	1,787	990	998	659	205	208	134	.....	.....	.....
62	Places of 50,000–99,999	2,028	948	788	482	284	197	222	127	160	61	.....
63	Places of 25,000–49,999	2,289	1,446	930	670	611	235	105	70	80	48	62
64	Places of 10,000–24,999	3,451	2,189	1,710	884	561	405	240	122	109	54	48
65	Places of 5,000–9,999	2,384	1,717	1,278	976	596	329	231	155	116	94	48
66	Places of 2,500–4,999	2,277	1,618	1,086	595	316	172	126	96	70	45	44
69	Rural territory	40,841	36,926	33,656	25,227	19,648	15,224	11,739	8,945	6,714	4,986	3,728
70	Places of 1,000–2,499	2,509	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
71	Places under 1,000	2,249	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
72	Other rural territory	36,083	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

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Chart 2-B

Shown in Thousands. (*96,468* means *96,468,000*).

Series A 57–72. Population in Urban and Rural Territory, by Size of Place: 1790 to 1970

[In thousands. For U.S. total population, see series A 2. For definition of urban, see text for series A 43–56]

Series No.	Class and population size	1970 [1]	1960		1950		1940	1930	1920	1910	1900
			Including Alaska and Hawaii	Conterminous United States	1950 urban definition	1940 urban definition					
57	Urban territory	149,325	125,269	124,699	96,468	88,927	74,424	68,955	54,158	41,999	30,160
58	Places of 1,000,000 or more	18,769	17,484	17,484	17,404	17,404	15,911	15,065	10,146	8,501	6,429
59	Places of 500,000–999,999	12,967	11,111	11,111	9,187	9,187	6,457	5,764	6,224	5,011	1,645
60	Places of 250,000–499,999	10,442	10,766	10,472	8,242	8,242	7,828	7,956	4,541	3,950	2,861
61	Places of 100,000–249,999	14,286	11,652	11,652	9,479	9,614	7,793	7,541	6,519	4,840	3,272
62	Places of 50,000–99,999	16,724	13,836	13,836	8,931	9,073	7,844	6,491	5,265	4,179	2,709
63	Places of 25,000–49,999	17,848	14,951	14,855	8,806	9,496	7,417	6,426	5,075	4,023	2,801
64	Places of 10,000–24,999	21,415	17,568	17,513	11,867	12,467	9,967	9,097	7,035	5,549	4,238
65	Places of 5,000–9,999	12,924	9,780	9,739	8,139	7,879	6,682	5,897	4,968	4,217	3,204
66	Places of 2,500–4,999	8,038	7,580	7,542	6,490	5,565	5,026	4,718	4,386	3,728	2,899
67	Places under 2,500	727	690	690	578	----------	----------	----------	----------	----------	----------
68	Other urban territory	15,186	9,851	9,806	7,344	----------	----------	----------	----------	----------	----------
69	Rural territory	53,887	54,954	53,765	54,230	61,770	57,246	53,830	51,553	49,973	45,835
70	Places of 1,000–2,499	6,656	6,497	6,440	6,478	5,883	5,027	4,821	4,712	4,234	3,298
71	Places under 1,000	3,852	3,894	3,888	4,081	4,129	4,316	4,863	4,255	3,930	3,003
72	Other rural territory	43,379	43,564	43,437	43,725	52,258	47,903	44,637	42,586	41,809	39,533

Chart 3

Shown in thousands.

LABOR FORCE

Series D 167–181. Labor Force and Employment, by Industry: 1800 to 1960

[In thousands of persons 10 years old and over]

Year	Labor force			Employment										
								Manufacturing			Trade	Transport		Service	
	Total	Free	Slave	Agriculture	Fishing	Mining	Construction	Total persons engaged	Cotton textile wage earners	Primary iron and steel wage earners		Ocean vessels	Railway	Teachers	Domestics
	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181
1960	74,060	----------	----------	5,970	45	709	3,640	17,145	300	530	14,051	135	883	1,850	2,489
1950	65,470	----------	----------	7,370	77	901	3,029	15,648	350	550	12,152	130	1,373	1,270	1,995
1940	56,290	----------	----------	9,575	60	925	1,876	11,309	400	485	9,328	150	1,160	1,086	2,300
1930	48,830	----------	----------	10,560	73	1,009	1,988	9,884	372	375	8,122	160	1,659	1,044	2,270
1920	41,610	----------	----------	10,790	53	1,180	1,233	11,190	450	460	5,845	205	2,236	752	1,660
1910	37,480	----------	----------	11,770	68	1,068	1,949	8,332	370	306	5,320	150	1,855	595	2,090
1900	29,070	----------	----------	11,680	69	637	1,665	6,895	303	222	3,970	105	1,040	436	1,800
1890	23,320	----------	----------	9,960	60	440	1,510	4,390	222	149	2,960	120	750	350	1,580
1880	17,390	----------	----------	8,920	41	280	900	3,290	175	130	1,930	125	416	230	1,130
1870	12,930	----------	----------	6,790	28	180	780	2,470	135	78	1,310	135	160	170	1,000
1860	11,110	8,770	2,340	5,880	31	176	520	1,530	122	43	890	145	80	115	600
1850	8,250	6,280	1,970	4,520	30	102	410	1,200	92	35	530	135	20	80	350
1840	5,660	4,180	1,480	3,570	24	32	290	500	72	24	350	95	7	45	240
1830	4,200	3,020	1,180	2,965	15	22	----------	(NA)	55	20	----------	70	----------	30	160
1820	3,135	2,185	950	2,470	14	13	----------	(NA)	12	5	----------	50	----------	20	110
1810	2,320	1,590	740	1,950	6	11	----------	75	10	5	----------	60	----------	12	70
1800	1,900	1,370	530	1,400	5	10	----------	----------	1	1	----------	40	----------	5	40

NA Not available.

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Series F 1–5. Gross National Product, Total and Per Capita, in Current and 1958 Prices: 1869 to 1970

Year	Current prices		1958 prices		Implicit price index (1958 = 100)	Year	Current prices		1958 prices		Implicit price index (1958 = 100)
	Total	Per capita	Total	Per capita			Total	Per capita	Total	Per capita	
	1	2	3	4	5		1	2	3	4	5
	Bil. dol.	*Dollars*	*Bil. dol.*	*Dollars*			*Bil. dol.*	*Dollars*	*Bil. dol.*	*Dollars*	
1970	977.1	4,808	722.5	3,555	135.2	1928	97.0	805	190.9	1,584	50.8
1969	930.3	4,590	725.6	3,580	128.2	1927	94.9	797	189.8	1,594	50.0
1968	864.2	4,306	706.6	3,521	122.3	1926	97.0	828	190.0	1,619	51.1
1967	793.9	3,995	675.2	3,398	117.6						
1966	749.9	3,815	658.1	3,348	113.9	1925	93.1	804	179.4	1,549	51.9
						1924	84.7	742	165.6	1,450	51.2
1965	684.9	3,525	617.8	3,180	110.9	1923	85.1	760	165.9	1,482	51.3
1964	632.4	3,296	581.1	3,028	108.8	1922	74.1	673	148.0	1,345	50.1
1963	590.5	3,120	551.0	2,912	107.2	1921	69.6	641	127.8	1,177	54.5
1962	560.8	3,004	529.8	2,840	105.8						
1961	520.1	2,831	497.2	2,706	104.6	1920	91.5	860	140.0	1,315	65.4
						1919	84.0	804	146.4	1,401	57.4
1960 [6]	503.7	2,788	487.7	2,699	103.3	1918	76.4	740	151.8	1,471	50.3
1959	483.7	2,731	475.9	2,688	101.6	1917	60.4	585	135.2	1,310	44.7
1958	447.3	2,569	447.3	2,569	100.0	1916	48.3	473	134.3	1,317	36.0
1957	441.1	2,576	452.5	2,642	97.5						
1956	419.2	2,492	446.1	2,652	94.0	1915	40.0	398	124.5	1,238	32.1
						1914	38.6	389	125.6	1,267	30.7
1955	398.0	2,408	438.0	2,650	90.9	1913	39.6	407	131.4	1,351	30.1
1954	364.8	2,247	407.0	2,506	89.6	1912	39.4	413	130.2	1,366	30.3
1953	364.6	2,285	415.8	2,587	88.3	1911	35.8	382	123.3	1,318	29.1
1952	345.5	2,201	395.1	2,517	87.5						
1951	328.4	2,129	383.4	2,485	85.6	1910	35.3	382	120.1	1,299	29.4
						1909	33.4	369	116.8	1,290	28.6
1950	284.8	1,877	355.3	2,342	80.2	1908	27.7	312	100.2	1,130	27.6
1949	256.5	1,719	324.1	2,172	79.1	1907	30.4	349	109.2	1,255	27.8
1948	257.6	1,757	323.7	2,208	79.6	1906	33.7	336	107.5	1,288	26.7
1947	231.3	1,606	309.9	2,150	74.6						
1946	208.5	1,475	312.6	2,211	66.7	1905	25.1	299	96.3	1,149	26.1
						1904	22.9	279	89.7	1,092	25.6
1945	211.9	1,515	355.2	2,538	59.7	1903	22.9	284	90.8	1,126	25.2
1944	210.1	1,518	361.3	2,611	58.2	1902	21.6	273	86.5	1,093	24.9
1943	191.6	1,401	337.1	2,465	56.8	1901	20.7	267	85.7	1,105	24.1
1942	157.9	1,171	297.8	2,208	53.0						
1941	124.5	934	263.7	1,977	47.2	1900	18.7	246	76.9	1,011	24.3
						1899	17.4	233	74.8	1,000	23.2
1940	99.7	754	227.2	1,720	43.9	1898	16.4	210	68.6	933	22.4
1939	90.5	691	209.4	1,598	43.2	1897	14.6	202	67.1	930	21.8
1938	84.7	651	192.9	1,484	43.9	1896	13.3	188	61.8	865	21.7
1937	90.4	701	203.2	1,576	44.5						
1936	82.5	643	193.0	1,506	42.7	1895	13.9	200	62.6	900	22.3
						1894	12.6	185	55.9	819	22.6
1935	72.2	567	169.5	1,331	42.6	1893	13.8	206	57.5	859	24.1
1934	65.1	514	154.3	1,220	42.2	1892	14.3	218	60.4	920	23.6
1933	55.6	442	141 5	1,126	39.3	1891	13.5	210	55.1	856	24.6
1932	58.0	465	144.2	1,154	40.2						
1931	75.8	611	169.3	1,364	44.8	1890	13.1	208	52.7	836	24.9
						1889	12.5	202	49.1	795	25.4
1930	90.4	734	183.5	1,490	49.3	1879–1888 [1]	11.2	205	42.4	774	26.5
1929	103.1	847	203.6	1,671	50.6	1869–1878 [1]	7.4	170	23.1	531	32.1

Chart 5

Series B 148. Infant Mortality Rate, for Massachusetts: 1851 to 1970

[Deaths under 1 year per 1,000 live births. Excludes fetal deaths. Data for 1940 to 1968 are by place of residence; for other years, by place of occurrence]

Year	Rate	Year or period	Rate	Period	Rate	Period	Rate
	148		148		148		148
1970	16.8	1961	21.6	1940–44	34.3	1895–99	153.2
1969	18.3	1960	21.6	1935–39	43.2	1890–94	163.2
1968	19.9	1959	22.3	1930–34	59.9	1885–89	156.5
1967	20.0	1958	22.8	1925–29	67.6	1880–84	161.8
1966	21.2	1957	22.7	1920–24	78.7	1875–79	156.8
1965	23.2	1956	22.4	1915–19	100.2	1870–74	170.8
1964 [1]	19.8	1955	21.9	1910–14	116.7	1865–69	146.8
1963	20.6	1950–54	22.8	1905–09	124.8	1860–64	142.5
1962	21.8	1945–49	28.4	1900–04	141.4	1855–59	123.9
						1851–54	131.1

58

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Chart 6

Series B 126–135. Expectation of Life at Specified Ages, by Sex, for Massachusetts: 1850 to 1949–51

[In years]

Year or period	At birth		Age 20		Age 40		Age 60		Age 70	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
	126	127	128	129	130	131	132	133	134	135
1949–51	66.7	72.1	49.8	54.2	30.7	35.2	15.4	18.3	9.9	11.6
1939–41 [1]	63.3	67.6	47.4	51.0	29.3	32.6	14.5	16.4	9.1	10.2
1929–31 [1]	59.8	62.6	46.1	48.5	29.0	31.2	14.8	15.8	8.9	9.9
1919–20 [1]	54.1	56.6	44.6	45.5	28.8	30.0	14.4	15.4	8.9	9.6
1909–11	49.8	53.1	42.5	44.9	27.0	29.0	13.4	14.8	8.6	9.5
1900–02	46.1	49.4	41.8	43.7	27.2	28.8	13.9	15.1	8.9	9.6
1893–97	44.1	46.6	41.2	42.8	27.4	29.0	14.4	15.7	9.3	10.4
1890	42.5	44.5	40.7	42.0	27.4	28.8	14.7	15.7	9.4	10.2
1878–82	41.7	43.5	42.2	42.8	28.9	30.3	15.6	16.9	10.8	11.8
1855	38.7	40.9	39.8	39.9	27.0	28.8	14.4	15.6	(NA)	(NA)
1850	38.8	40.5	40.1	40.2	27.9	29.8	15.6	17.0	10.2	11.3

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ACTIVITY 5

LOOKING BACK, LOOKING AHEAD

Seven periods of U.S. history are listed below. For *each* period, do library research to answer questions 1–5 that follow. Some good sources of information are: *Historical Statistics of the United States, America in Time,* or any general encyclopedia. Your librarian can lead you to other sources.

1. How many people were there?
2. What, if any, industries were there?
3. What was the role of agriculture?
4. How did most people earn their money?
5. What major things were invented during this period?

The Early Colonial Period (around 1630):

1. _____

2. _____

3. _____

4. _____

5. _____

The First Federal Years (around 1790):

1. _____

2. _____

3. _____

4. _____

5. _____

Civil War Times (around 1860):

1. _____

2. _____

3. _____

4. _____

5. _____

The Roaring 20's (around 1925):

1. _____

2. _____

3. _____

4. _____

5. _____

World War II (1940-1945):

1. _____

2. _____

3. _____

4. _____

5. _____

Modern Times (since about the time of your birth — 1970–present):

1. _____

2. _____

3. _____

4. _____

5. _____

The Near Future (the 1980's):

1. _____

2. _____

3. _____

4. _____

5. _____

ACTIVITY 6

CURVES: SHOWING CHANGE VISUALLY

To understand changes (for example, changes in population growth) it is necessary to think like a mathematician. The charts below will help you understand this. It is important to know how to read these charts and to understand "chart vocabulary."

J—SHAPED (Increasing)

J-shaped curves show a trend that starts slowly and then increases rapidly with no indication of reversal. When it increases rapidly at a constant *rate,* it is called an "exponential" curve.

J—SHAPED (Decreasing)

Reversed J-shaped curves start slowly and then decrease rapidly. When it decreases rapidly by a constant *rate,* it is called an "exponential" curve.

S—SHAPED CURVE

S-shaped curves indicate a trend that started slowly, went through a phase of rapid change, and started to slow down at some point. This curve depicts the course of many natural developments.

SPIKE CURVE

Spike curves indicate a trend that maintains a low level, then takes a very rapid increase and a rapid decrease, and then remains at about the same level as before the increase.

For each of the following charts or graphs decide which kind of change curve is illustrated. Check "S-shaped," "J-shaped (Increasing)," "J-shaped (Decreasing)," or "Spike."

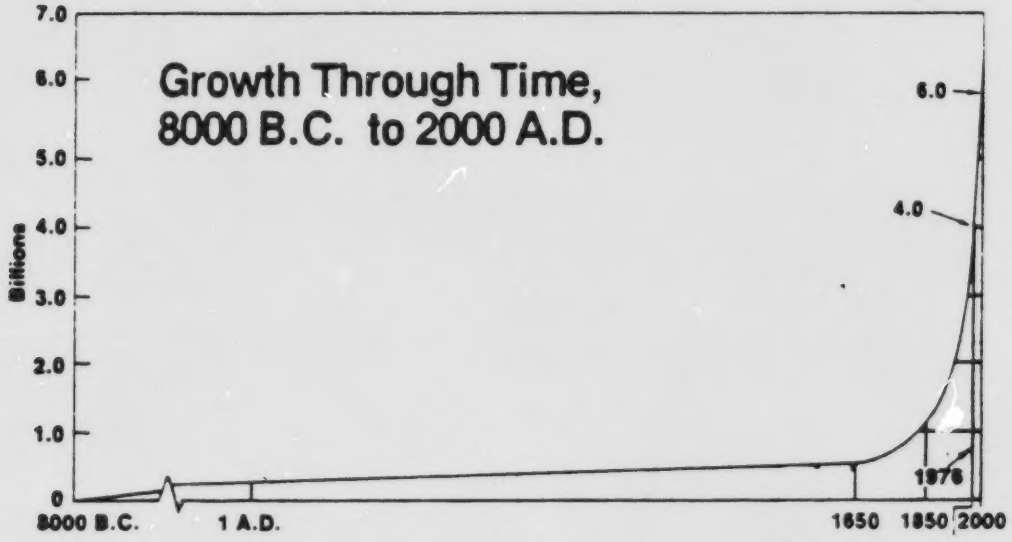


Figure 4.2. Growth through time, 800 B.C. to 2000 A.D. (Source. Population Reference Bureau, Inc., 1745 N Street, N.W. Washington, D.C. 20036.)

S-shaped____ J-shaped (Increasing)____ J-shaped (Decreasing)____ or Spike____

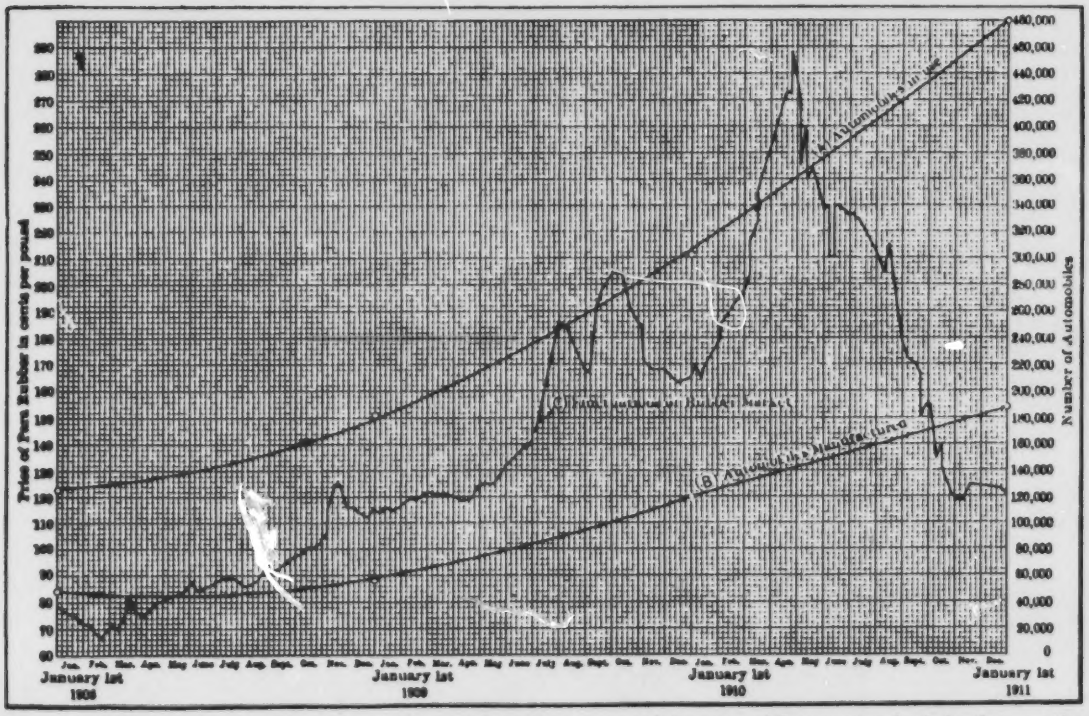
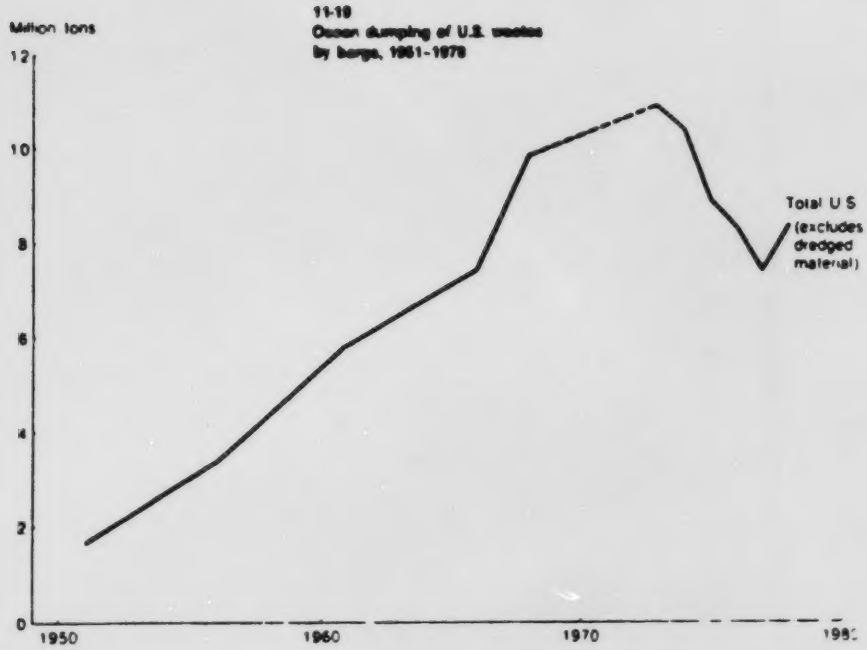


FIG. 86.—Charted to give at a glance the rubber market for three years and the automobile output and sale for the same time.

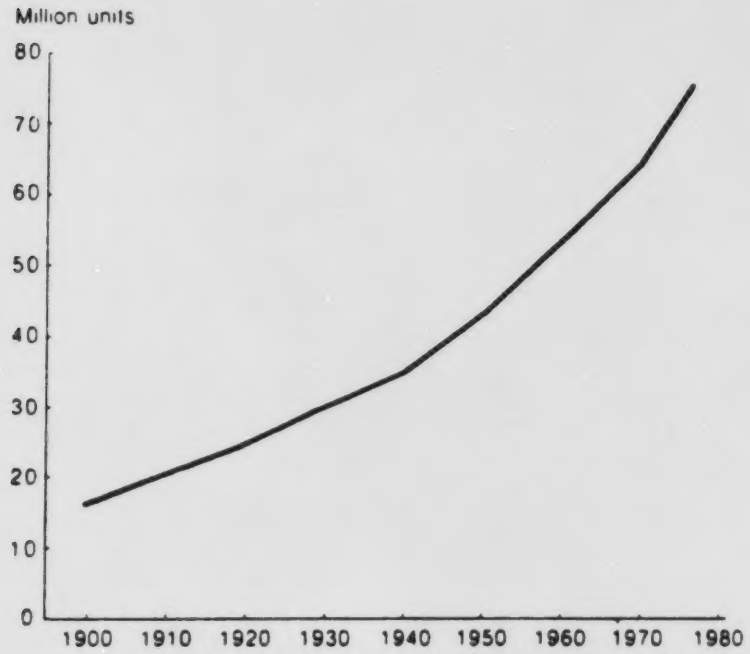
S-shaped____ J-shaped (Increasing)____ J-shaped (Decreasing)____ or Spike____

APPLICATIONS

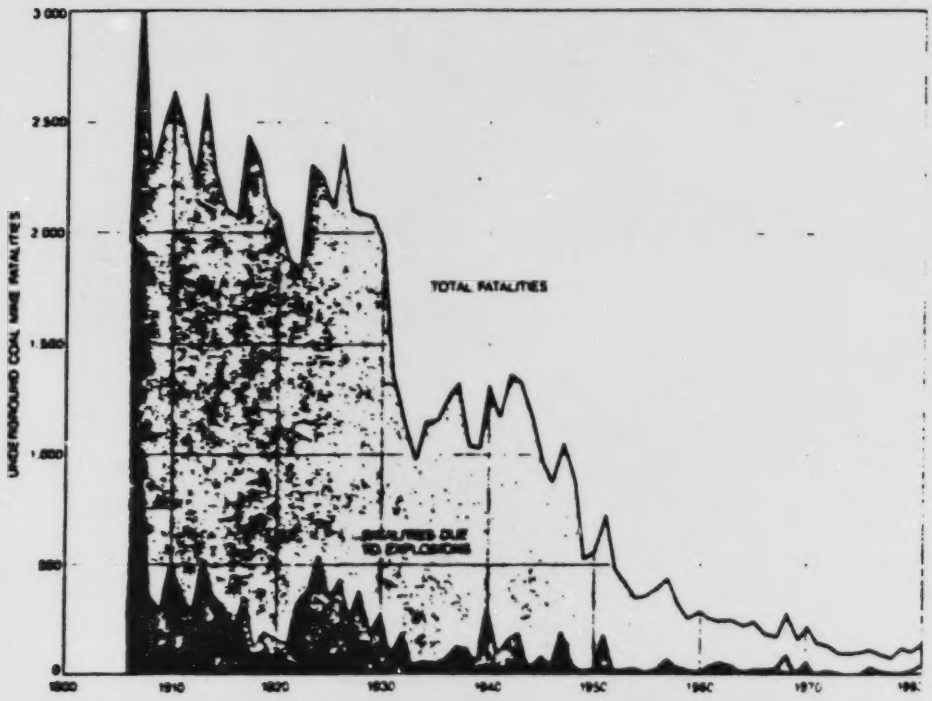


S-shaped____ J-shaped (Increasing)____ J-shaped (Decreasing)____ or Spike____

Occupied housing units, 1900-1977



S-shaped____ J-shaped (Increasing)____ J-shaped (Decreasing)____ or Spike____



FATALITY RATE IN UNDERGROUND COAL MINES

S-shaped____ J-shaped (Increasing)____ J-shaped (Decreasing)____ or Spike____

ACTIVITY 7

EXPONENTIALITY

Mathematicians call one type of very rapid growth rate "exponential," from the word "exponent." Exponents (or powers as they are sometimes called) are simple ways of showing multiplication. Using exponents, if you want to show that the number 5 is multiplied by itself 4 times, you would write 5^4. This is the same as saying 5x5x5x5. The 5 is the number that will be multiplied and the 4 — the exponent or power — is the number of times it will be multiplied. The answer would be 5x5 = 25x5 = 125x5 = 625. You can see that exponential growth can be very rapid and constant.

Another example of how to think about exponential growth could be a plan for saving money. Suppose you want to double your savings every day for two weeks. (Doubling something is a 100% increase.) Assume that you are able to start on the first day with a savings of *2 cents* obtained in change at lunch. Your goal is to save twice the amount each day as you had the previous day. On the second day you would have to save 4 cents (2x2), on the third day you would need to save 8 cents (2x2x2), and so on until the 14th day. The solid line on the chart on the next page shows the amounts you would need to save each day. Do you think you could carry out this savings program through day 14? Could you save the amount on day 7 without much trouble? Probably not, so it makes sense to consider changing the *rate* of your savings.

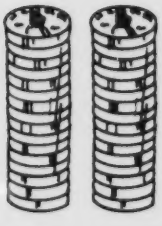
DOUBLING YOUR SAVINGS

DAY 1

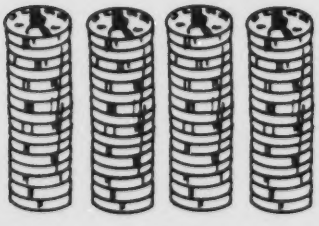
DAY 2

DAY 3

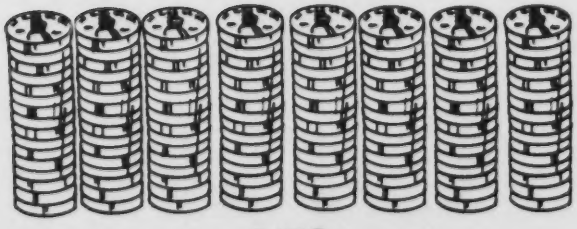
DAY 4



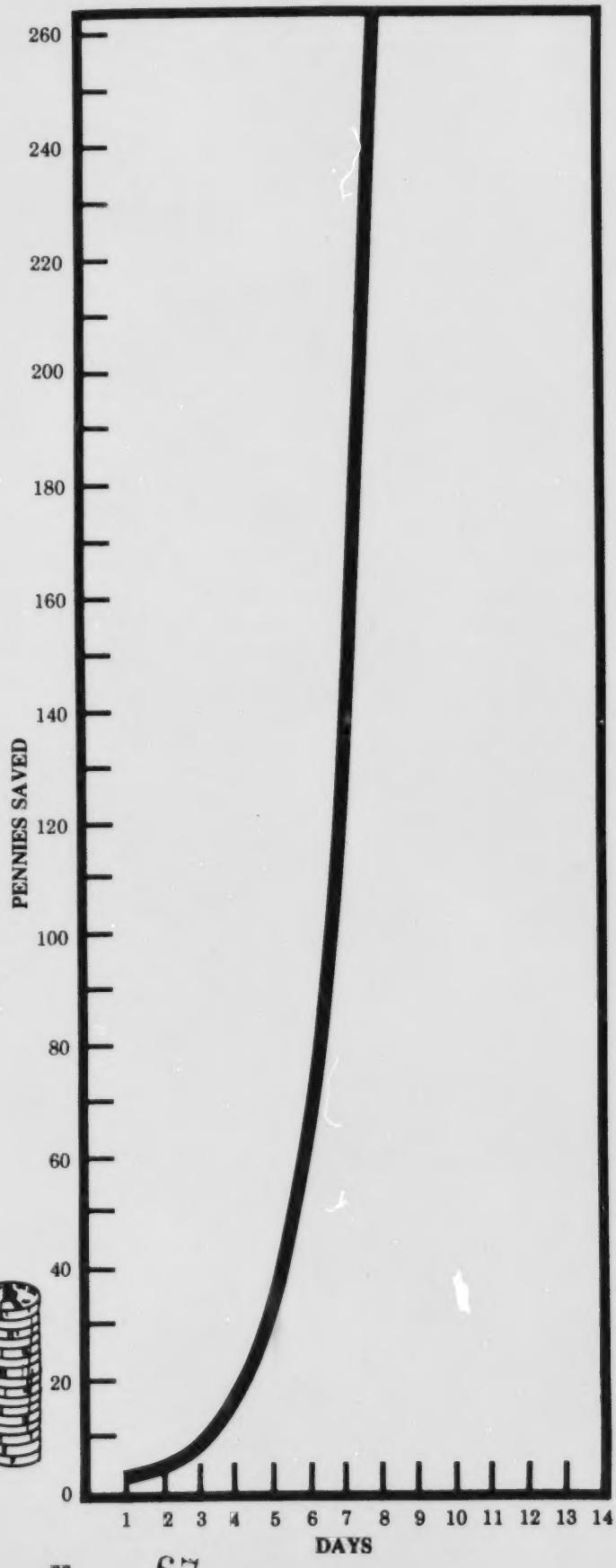
DAY 5



DAY 6



DAY 7

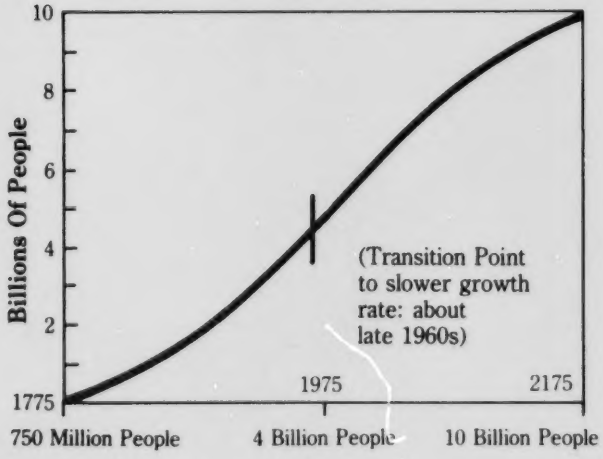


If on day 6 you could no longer afford to double your savings, you might choose to increase your savings by only one-tenth (or 10%) each day. With this new savings plan, how much do you now need to save on day 7? How much on day 14? Note that the dotted line on the chart at the right shows the different amounts you need to save when you change the *rate* of growth to the 10% per day you originally decided on. With the 10 percent plan you still save more pennies each day, so the *amount* of pennies increases, but they accumulate at a very different, and much slower, *rate* than with the 100 percent plan. Many kinds of growth, including population growth, can follow the same patterns, except of course that population can also decline.

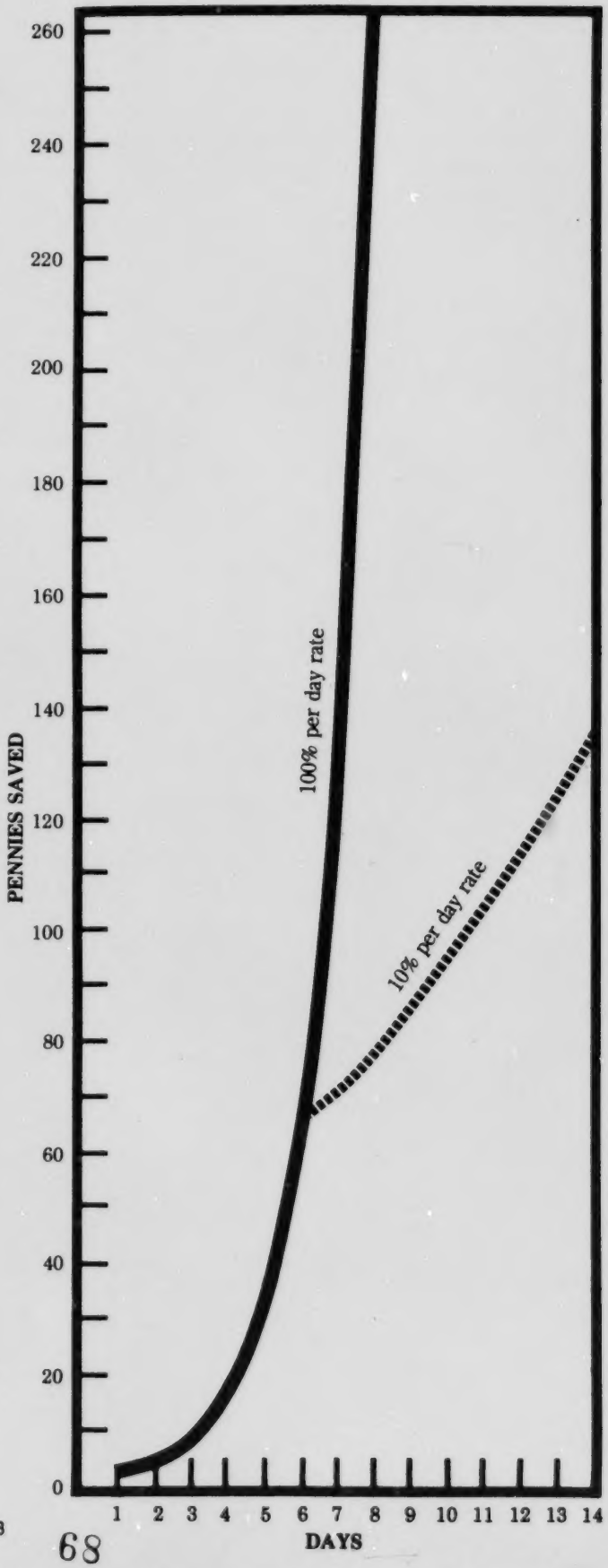
Areas where exponential growth has occurred can be found throughout history. However, exponential growth is very hard to maintain.

For example, during the early stages of the Great Transition the population growth rate was very rapid, producing a curve, or trend, similar to the one produced in the "100 percent savings program." But the world's population growth curve is now starting to flatten out, just as occurred when the 10 percent savings program was started. The chart below shows this flattening out from a *J-shape*. The curve is becoming an *S-shape* as the *rate* of growth slows down.

WORLD POPULATION GROWTH RATE DURING THE GREAT TRANSITION



Source: Kahn, H. *World Economic Development*, Morrow Quill, New York, 1979, p. 66.



The flattening curve looks similar to the dotted line curve in the pennies chart, when we stopped doubling our pennies on day 6 and only increased them by 10 percent each day. Both curves indicate that the *total number* of people (or pennies saved) is still growing, but not as rapidly as they once were.

Which of the following describe exponential change? Circle "yes" if the change during the period of time *is* exponential, "no" if the change *is not* exponential.

1. Between 1965 and 1980, the murder rate in the U.S. increased by 5% per year.

   YES or NO

2. Between 1965 and 1980, the murder rate in the U.S. doubled.

   YES or NO

3. Between 1979 and 1980, 63% more families went on food stamps in Arizona.

   YES or NO

4. If you put $100 in the bank at 7% annual interest, and if you have the interest added to your account as it accrues, in 10 years you will have $200, and in 20 years you will have $400.

   YES or NO

5. The population of the region grew at a steady 1% per year for 5 years, then grew at ½% per year.

   YES or NO

6. The population grew 5% per year for 5 years, then 6% for 5 years, then slowed to 5% again for 5 years.

   YES or NO

ACTIVITY 8

TRENDS AND COUNTERVAILING FORCES

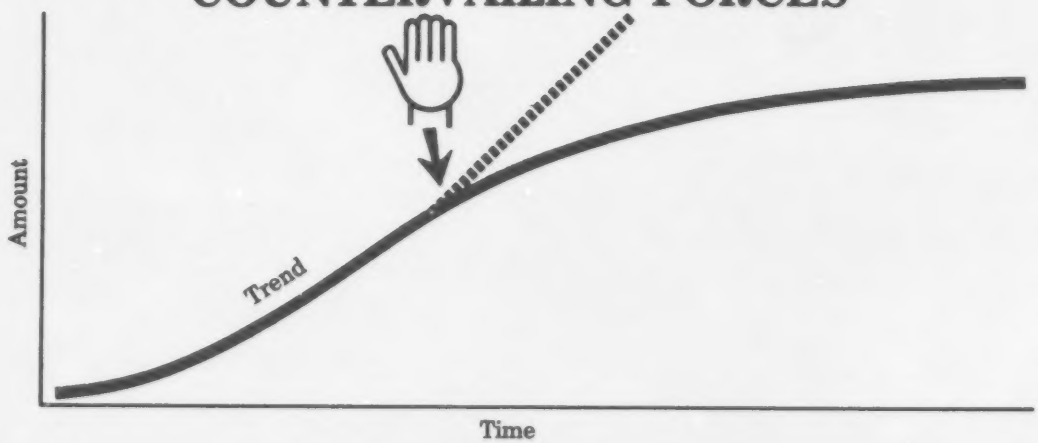
Trends, like a trend in population growth rate, can change for many reasons. Trends are often charted or graphed by scientists. This enables people to view a trend in visual form. For example, an "S-shaped" curve appears to bend over as if some force starts to push it down. This force is sometimes called a *countervailing force. A countervailing force occurs when a trend creates a force that opposes it.* Many macro-historians believe that the trend of increasing wealth in a civilization can be halted because increasing wealth can make a civilization careless and lazy, which can lead to a reduction in the factors that produced the increase in the first place.

Whenever we predict, we must consider not only recent trends (like population growth at high rates), but also the impact of countervailing forces, like decisions to limit family size. Very few trends can continue for long periods of time without generating opposing forces affecting their direction or rate. History shows many instances of societies like the Roman Empire that have grown in power and influence but then declined because of countervailing forces. Other societies then grow in strength, encounter other types of forces and, in turn, decline.

A more recent example of countervailing forces can be seen by studying U.S. gasoline prices. In the 1970's U.S. gasoline prices rose very sharply due to an oil embargo. Some people thought that these prices would continue to rise indefinitely, so companies bought huge quantities of gasoline and stored it for later sales. And, since oil producing countries were getting such high prices for their product, they produced and sold as much as they could. In response to all this, people could not afford as much gas as before, so they drove less and purchased less gasoline. All these actions created what many economists in the early 1980's called an oil "glut," and, in reaction to this glut (or over-supply of product) prices began to fall. In this case, economic conditions (and other political considerations) eventually created a countervailing force to the increasing price trend of gasoline. New technological developments can create a countervailing force too (like the development of a synthetic replacement for gasoline).

Reproduced on the next page are two letters that could appear in a newspaper. Each letter describes a trend that concerns the author (for example, the world's population is growing too fast or we are using too much gas and oil). Read each letter. Then write a one-page response to each letter that provides an alternative viewpoint. Your response should include a consideration of specific countervailing forces that could effect the trend described in that letter.

COUNTERVAILING FORCES



Letter 1:

Dear Editor:

Do you realize that the world's population is doubling every 35 years? This is a fact which we must face up to: the world is finite, and it presently holds over 4 billion people. At this rate of growth, how can the earth possibly hold 8 billion people 35 years from now?

The problem of world population growth is made worse by our technological progress. Since births now consistently outnumber deaths, our longer life expectancy is making us too populous for our own good.

Everyone already feels crowded. Look around you right now: can you imagine *twice* as many people as you now see, constantly milling around, competing for the same goods and services which you need to live your life well?

Well, that's what the world is going to be like if we don't do something soon about our out-of-control population growth!

Signed,

Feeling Crowded

Letter 2:

Dear Editor:

Apparently we have not learned a lesson from the oil and gas shortages of 1974–75. If we continue to consume oil at the rate we were in 1973 (which we seem to be doing), we have only 80 years left in which to use up the remaining oil, and 112 years to use up the natural gas. If our consumption of these nonrenewable resources increases, we have only 35 "years" of oil left, and 30 years of natural gas. What will the world do when it runs out of oil and gas? It stops running!

The only way to adequately address this alarming problem is for all of us to commit ourselves to drastically different life styles. We must stop consuming as much, since it takes energy both to create consummable goods and to consume them. We must restructure the world's economy by slowing down economic growth, and by re-distributing these scarce resources of oil and gas so that all nations will have enough to supply their basic needs, until we can figure out a way to supply our energy needs in the future. This will take pain and sacrifice, but it's the only way to avoid disaster.

Signed,

Out of Gas

ACTIVITY 9

WORLD ECONOMIC INTERDEPENDENCE: EXPORTS AND IMPORTS

Read the two brief sections and one article that follow. Then, fill out the charts at the end of this activity.

U.S. Exports and Employment

U.S. exports create a lot of jobs in the United States. The employment generated by exports is much greater than just the workers producing the final products that are exported. Exports create a large demand for employment that spreads throughout the U.S. economy. These jobs include all the indirect employment needed to produce goods and services supplied to export producers, the employment directly needed by the export producers to produce exports, the employment directly and indirectly needed to move products to ports of exportation, and employment related to the international banking end of an export transaction.

- In 1982 over 5 million workers owed their jobs to U.S. exports.*
- Employment generated by total exports is mainly in manufacturing and services. In 1980, 49 percent of export related jobs were in manufacturing and 37 percent in services.*
- The importance of export employment to individual industry groups varies widely. In 1982, export-related employment accounted for:*
  - — 1 in 8 jobs in manufacturing
  - — 1 in 30 jobs in services.

The U.S. exports many items. These include food, agricultural machinery and related products, engineering products (e.g., aircraft, computer parts), medical products (e.g., drugs, machinery) and even information. So, many workers in the U.S. depend on exporting for their jobs, and many people in other countries depend on the U.S. for the things that we export to them.

Imports and World Trade

How many objects can you find in your home that were made in foreign countries? Certainly, you know that many of the things that people in the U.S. buy were sent to us by other nations. Cars, foods, clothing, and electronic equipment are just some of the many things that the U.S. buys from other countries.

Some of the countries that we import from are "rich" countries (e.g., Japan, West Germany), others are relatively poor countries (e.g., Nigeria, China). In each case, U.S. dollars that purchase products made in foreign countries help their economy grow. And, when we export our products to these countries, they help our economy, too.

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*Source: Lester A. Davis, "Domestic Employment Generated by U.S. Exports," Office of Trade and Investment Analysis, International Trade Administration, U.S. Department of Commerce (May, 1983), Executive Summary (Data corrected to be consistent with the body of the report.)

For U.S., an Age of Reliance on Other Nations

The struggle for economic strength can only grow more intense. America's strong suit: Brainpower.

Like it or not, the U.S. is destined to become more and more dependent on other countries for the goods and services it needs.

For all nations, competition for a share of the world economy will be brisk because expansion of trade is expected to slow from the heady growth that took place in the 1960s and 1970s.

Trade wars and protectionism will increase as governments try to keep jobs from being lost to foreign competition, and international monetary authorities will be hard pressed from time to time to accommodate developing countries suffering debt problems.

Increasingly, the U.S. will move from a nation that not long ago was almost totally self-sufficient to one heavily reliant on other countries for many of its needs and wants. Washington trade attorney Bart Fisher predicts that U.S. trade with other nations will equal 40 percent of the gross national product by the year 2000—up from about 20 percent now. In 1950, foreign trade was just 2 percent of GNP.

The U.S. also will join hands with trading partners in all sorts of joint ventures. There is growing talk among multinational corporations of a "world car," parts of which would be assembled in different countries.

But don't look for the birth of new and powerful cartels, such as the Organization of Petroleum Exporting Countries. Experts note that OPEC's current troubles show that world markets eventually undermine a system based on artificially high prices.

Still, just as OPEC called the shots in the world economy through much of the last decade, other powers will emerge and claim markets that were once the province of established countries. For a closer look at the trade forecast for the next half-century—

U.S. and Canada

The U.S. will depend on its technical know-how and vast resources—rather than heavy industries. Large shares of the auto, steel and textile industries will be lost to developing nations, but the U.S. will remain a big seller of coal and grain.

Says economist Jimmy Wheeler of the Hudson Institute: "We will continue to be one of the most productive agriculture suppliers in the world."

The U.S. also will grab big shares of world exports of engineering products, aircraft, laser technology, telecommunications equipment, medicine, scientific instruments and engines.

"I see us and the Japanese as leaders of supertechnology products," says economist Gerard Adams of the Wharton School of the University of Pennsylvania. "That includes biotechnology, bioengineering, computer software and integrated circuits."

Rapid expansion will come, too, in trade of banking, insurance and other services, according to C. Fred Bergsten, director of the Institute for International Economics in Washington, D.C.

This country's northern neighbor is likely to come out ahead, too, because of its agricultural potential and its enormous supply of raw materials and energy sources. Forecaster Marvin Cetron of Arlington, Va., predicts that in 20 years Canada will be one of the three most prosperous nations in the world, along with the U.S. and Australia.

Western Europe

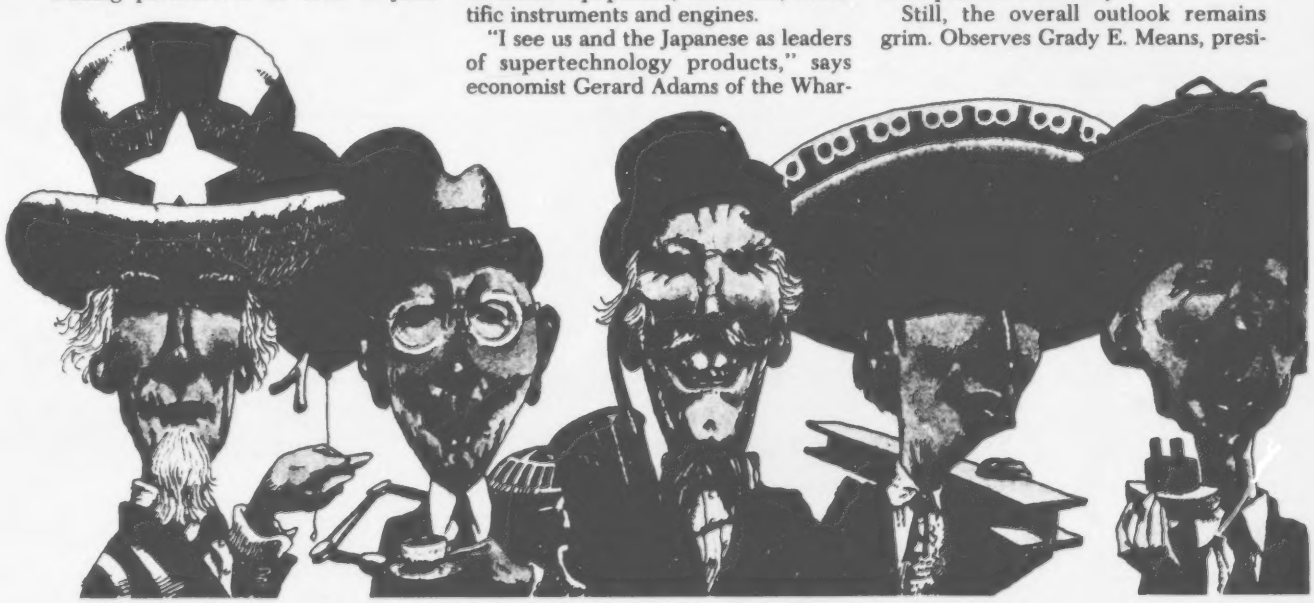
Tough times are in store for the region that dominated world commerce for centuries.

"The problem European countries will have is in horribly sick steel and auto industries," says attorney Fisher. "They won't be able to compete on wage scales with Far Eastern countries." Even in service fields, Europe is at least 10 years behind the U.S. and will have trouble catching up, he predicts.

One ray of hope for the European Economic Community is its growing aircraft industry. In addition, France and West Germany are likely to become major exporters of equipment and technology for nuclear power plants early in the next century.

In the years ahead, Britain will depend on oil, gas and financial services. Spain and Italy have some prospects in shoes and agriculture but may suffer from political instability.

Still, the overall outlook remains grim. Observes Grady E. Means, presi-



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dent of SAGE Associates, Inc., a Washington, D.C., management-consulting firm: "Economically and politically, Western Europe is very bleak."

The Soviet Bloc

If Europe falters, the Soviet Union won't be taking its place. Russia's strength is in its rich natural resources —not its manufacturing.

The U.S.S.R. will be selling energy to the West, particularly natural gas when the Siberian gas pipeline is completed. It also will increase sales of its huge reserves of gold and timber.

Because of their mounting debts, the Soviets may dump such commodities on world markets at low prices, says Mikhail Bernstam, East-West trade specialist at the Hoover Institution in Palo Alto, Calif.

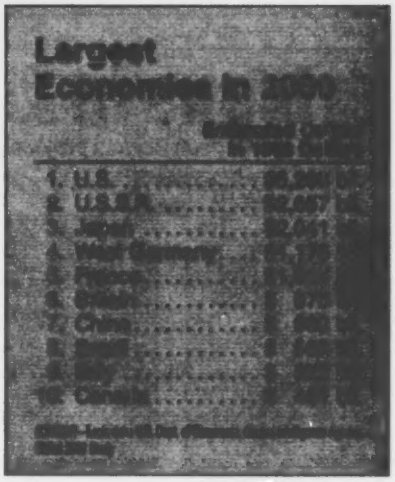
Others see little economic progress among Eastern European countries except for Yugoslavia and Hungary, both of which will gain stature as producers of textiles and related goods.

The Far East

The brightest outlook in the next half-century's trade picture is in East Asia. "Japan will continue to grow more rapidly than the rest of the industrial countries through the 1980s and beyond," says Wheeler of the Hudson Institute.

Many see Japan as a highly urbanized information-processing community, prominent in banking, biogenetics, computer technology and other electronics industries.

But Japan may well lose its steel and auto industries to other countries in the region. "Taiwan, Hong Kong, Singapore and South Korea are at about the same stage of transformation that Japan



was in the late 1960s and 1970s," says Ramon Myers, senior fellow at the Hoover Institution.

He predicts that these four economic upstarts will improve steadily in such fields as textiles, machine tools, chemical products, metals and electronics.

Moving in to take their places may be the Philippines, Thailand, Indonesia and Malaysia.

If they can feed their growing populations and their governments are stable, there is no reason these countries couldn't become producers of steel and textiles over the next 50 years. Similarly, India, with its teeming millions, could play a bigger role in low-skill manufacturing.

China, already battling for a larger share of the textile business in the United States, is another growing economic power. Experts say the Chinese have good business sense and are able to maintain low wage rates. Their supplies of oil, gas and coal and their agricultural potential also are coveted by foreign businesses.

Perhaps still bigger opportunities await Australia, with its large reserves of coal, oil, natural gas, iron, bauxite and uranium. The land down under will continue to boast one of the highest living standards in the world.

RICHARD ANDERSON FOR USN&WR

Mideast and Africa

Oil will be the driving force in the Mideast. A few industries based on petroleum, such as chemicals and plastics, may develop, but the region is given little chance of building an extensive manufacturing base.

Nor do economists see much chance of OPEC becoming a powerful force again. Reason: Industrialized nations will move increasingly toward development of alternative sources of energy.

For most of Africa, economists and international experts find little potential. "It's hard to see the Africans really catching up enough to be important participants," says economist Bergsten. "Most are still traditionally commodity exporters and will remain the same."

Unstable governments, socialist economies and poor roads and equipment will discourage business investment, in the view of Ian Butterfield, Africa specialist at the Heritage Foundation in Washington, D.C. South Africa's biggest industry may be arms exports to nations that cannot get them from the major powers.

Latin America

Mexico, Brazil and Argentina are expected to take advantage of natural resources and overcome their huge debt burdens to become leading economic powers over the next 50 years.

Economist Adams says Mexico could become a major steel producer: "They can ship in the iron ore from Venezuela and make steel on very favorable terms and sell it cheap on the world market."

Others predict that Brazil will be a leading auto maker, selling many cars to its own consumers in the next century. Meanwhile, Colombia, Peru and Chile will increase their shares of exports of textiles, shoes and similar goods.

Even with bankers banging on their doors today, countries in Latin America—and Asia as well—have great potential to become healthy exporters. "What it really takes is economic management," says Bergsten. "As we've seen in the last 20 years, many of these nations can, when properly run, be quite successful." □

Identifying Imports and Exports

How many things can you find around your house that were made in a foreign country?

CATEGORY	ITEM	MADE IN
1. Clothes	Shirt or Blouse	Hong Kong
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		

What specific things do these countries import from and export to other nations? You will need to do some library work to find the answers.

COUNTRY	MAJOR EXPORTS	MAJOR IMPORTS
MEXICO		
GREAT BRITAIN		
CHINA		
ITALY		
INDIA		
SAUDI ARABIA		
MALAYSIA		

ACTIVITY 10
CHANGE AGENTS: TECHNOLOGY

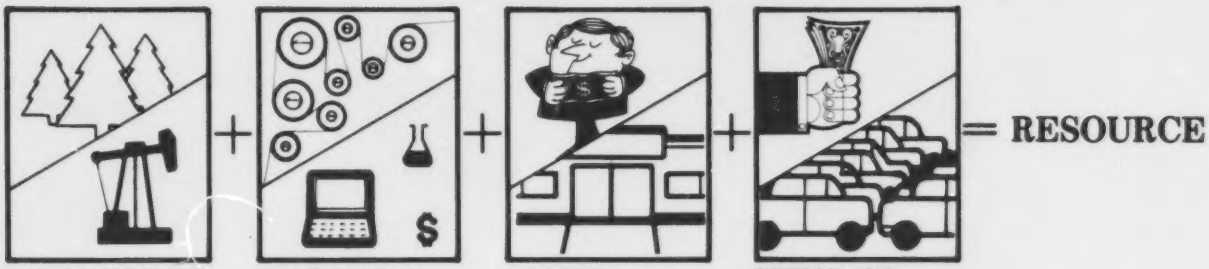
Technological change *is* exciting. To get a perspective on this change, interview people who are 25 and 50 years older than you are. Speak to your parents, grandparents, neighbors and teachers. Ask them what have been the biggest technological changes since they were in high school. Then, think about the future and make some guesses about technological change that could take place during the next 25 years and fill in this chart. "Long Distance Communications" has been filled in as an example. If you need more information, consult a general encyclopedia or other reference books which deal with technological change.

AVAILABLE TECHNOLOGY

	50 Years Ago	25 Years Ago	Today	25 Years From Now
Long Distance Communication	Mostly letters	Expensive phone calls transmitted over wires only	Low-cost calls often transmitted by satellite or microwave	Laser and fiber optic transmission; use of computers for teleconferencing; video-phones
Transportation				
Data Processing				
Television				
Medical Technology for Heart Diseases				
Automobiles				
Recorded Music				
Medicine for Infections				

RESOURCES FOR THE FUTURE

A NEW WAY OF LOOKING AT RESOURCES



RAW MATERIALS | TECHNOLOGY | SOCIETY | SUPPLY AND DEMAND

What is a resource? When you hear the word "resources" you probably think of raw materials, such as coal, oil, or copper. However, resources are much more than raw materials.

Scientists, politicians, and economists consider a resource to be a combination of many different things that together form that resource. So, one way to think of a resource is to consider it as consisting of four parts added together, like a math equation.

As you read this section, think of a resource being:

- the sum of raw materials that we have available, *plus* . . .
- the application of technology, *plus* . . .
- the people that make-up society, including their skills, organizations, capital (money), and institutions, *plus* . . .
- supply and demand for that resource.

Now that you know the parts of a resource, each part will be defined and discussed.

Raw Materials

Dictionaries in the early 1900's listed uranium as a mineral with unimportant uses. Dictionaries today, of course, give an entirely different definition of uranium. The *raw material* uranium did not change during this time, but our understanding of its usefulness changed.

Uranium is a radioactive element used to produce nuclear energy. Uranium became an important raw material — and ultimately a "resource" — when the three other parts of the resource equation were added. People had to develop a technology to mine, refine, and use uranium, and captial (money) had to be invested in these technologies. Then society had to have institutions such as an electric utility system to make use of the power that uranium could generate, schools to teach the design and operation of power plants, and an economic system that could support a project as large as the development of a nuclear power plant.

> URANIUM: A hard, radioactive, heavy, metallic element belonging to the chromium group. It occurs in combination with pitchblende and some other rare minerals, reducing to a hard, heavy metal having a nickel-white appearance. Upon disintegration certain radio-elements are formed among which are uranium X, ionium, radium,...Some compounds of uranium and of uranium acetate and of uranium nitrate are useful medicinally, particularly in some respiratory infections.
>
> New 20th Century Dictionary Unabridged, 1930

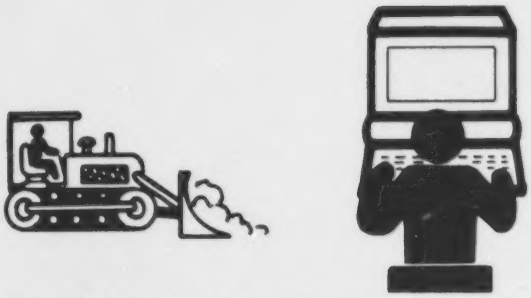
> URANIUM: A very hard, heavy, silvery, moderately malleable, radioactive metallic chemical element: it is found only in combination, chiefly in pitchblende, and is important in work on atomic energy, esp. in the isotope which can undergo continuous fission, and in the more plentiful isotope from which plutonium is produced.
>
> Webster's New World Dictionary Second College Edition, 1980.

In addition, there had to be something that people wanted to have (demand) that uranium could supply best or most cheaply. Since the consumption of electricity has increased rapidly for many years, nuclear power plants were built with uranium as a fuel.

Technology

Copper is another example of how raw materials become resources. Our planet has a lot of copper ore in the ground. But, for many years copper was not used at all. Even though there was much copper available, it was only a raw material in the ground until people found uses for it.

Society had to develop ways to find and use copper in order for it to become a resource. Rock with copper in it (copper ore) had to be mined, and then be converted into purer forms in order to be

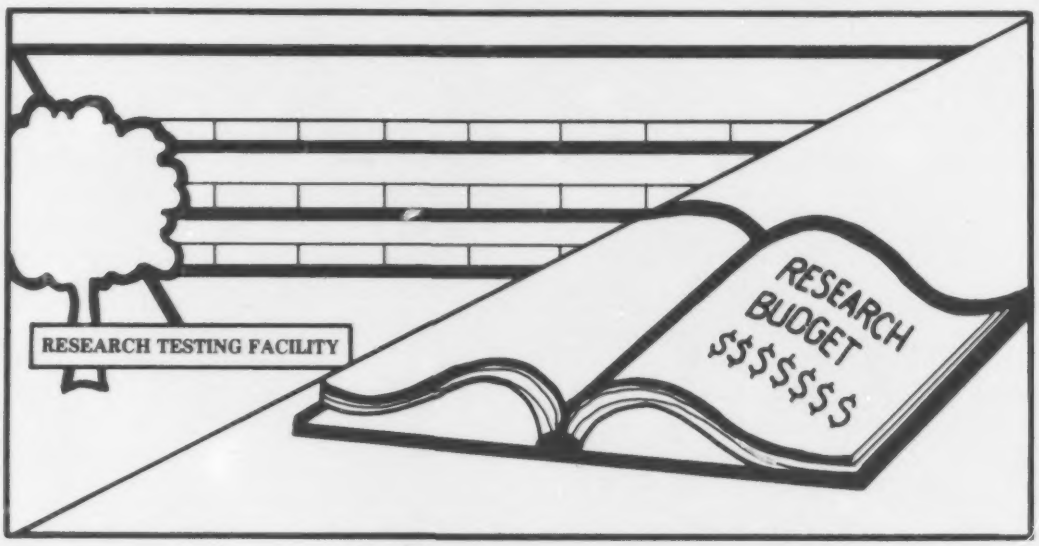


useful. This is called the *application of technology*. Early methods of refining copper were not very efficient and required copper sources to be high quality ore ("high quality" means rock that is about 20 percent copper). As technology improved, copper could be extracted from ore that had smaller amounts of copper in it.

Science and technology, through geological research and special tests, helped to find copper in ore that was only 1 percent copper; the development of earth-moving and digging machines meant that copper ore could be mined from deep in the ground; the invention of electric motors, lights and telephones created a large demand for copper, because it was discovered that copper wires were effective conductors of electricity.

Society

As demand increased, new copper-producing companies were formed and existing companies increased their productivity. New buildings and machinery had to be built and new processes had to be



developed. These expenses were met by people who had money to invest in hopes of gaining a profit. Technology and capital are both necessary to make a raw material into something useful.

However, raw materials, technical know-how and money cannot be successfully added together into a "resource" unless a society is organized. A way to put copper ore, equipment and workers together had to be found. Machine makers, sellers of copper and laborers needed the money system in order to avoid time-consuming trades. And, without an organized system of barges, roads and railways for transportation, copper would be used in few places outside the areas in which it is found. Society must also have certain institutions, like schools and systems of laws, for any raw material to be usable by more than just a few people.

Finally, and most important, none of these things could be accomplished without people. It is the special drive, ingenuity, and problem solving capacity of the human spirit that ultimately creates any resource.

Supply and Demand

Today we still have copper in the ground, and the means for mining, refining, transporting, and selling it. Then why do copper mines sometimes close, or stop finding and processing copper? The answer is that sometimes *demand* is too small (or existing *supplies* are too great). At these times it costs more to produce and transport copper than what people are willing to pay for it. Supply and demand are economic conditions that help determine the usefulness of a resource.

Keep this new definition of a resource ("resource equation") in mind. But remember — other people may still talk about resources as if they only consisted of the raw materials part of the resource equation.

The Debate Over Resources

There has been a great debate over resources and related issues during the last twenty years. For example, some scientists, economists and politicians have predicted that the world will soon run out of critical raw materials. These people have argued very strongly that we must radically change our policies if the world is going to have enough raw materials to survive. They have issued reports, written books, and given speeches in order to bring people's attention to the problem.* People who have taken this position are sometimes referred to as "limits to growth" advocates. In effect, they believe that we must limit economic growth and use of raw materials in order to avoid disaster.

Other scientists, economists and politicians disagree with the "limits to growth" arguments. They feel that we are *not* running out of these materials nearly as fast as "the other side" predicts. This group also suggests that, when you consider all the components of the resource equation, our raw materials will last a very long time. More importantly, they submit that even if we are running low on an important raw material there are viable alternatives to "running out."

This debate is not limited to just the issue of raw materials. It extends to questions like — how does the use of raw materials affect the environment? Will there be enough energy to meet our needs? And, will there be enough food to feed a growing world population?

People on both sides of the debate are predicting the future. Each group uses factors and information in a certain way. Perhaps you have read about this debate, or have heard reports on the news that we are "running out," or we are "destroying the planet."

What do you think about this issue? Would you predict that within your lifetime the world will exhaust its supply of critical raw materials? Or, do you think that the people who make such dire predictions are alarmists? What do you base your opinion on?

The rest of this unit focuses on these questions. Issues in four areas of this "resource debate" are discussed — raw materials, energy, food, and the environment. In each case, the components of the resource equation are considered. The discussion of these issues tends to counter the argument that we are running out or that we are destroying the planet. As a result of reading this section, you may discover a new perspective on these issues.

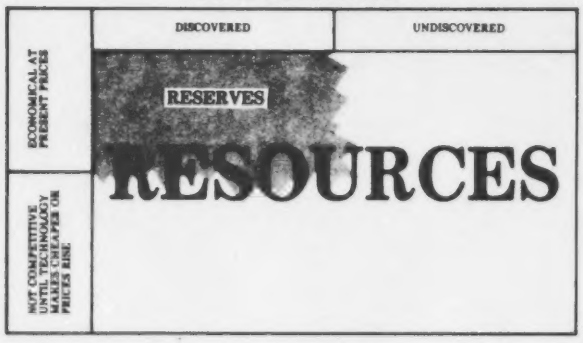
*The two most well known reports of this nature are *Limits to Growth* (New York, New American Library, 1972) and *The Global 2000 Report to the President* (Washington, Government Printing Office, 1980).

RESOURCE ISSUE 1: ARE WE RUNNING OUT OF RAW MATERIALS?

Two different words are used when people talk about how much of a material is available. "Resources" (don't confuse this use of the word "resources" with the resource equation you studied earlier) is often used when people talk about *the total quantity of the raw material that exists.* "Known reserves" are that portion of the total quantity that we have already found and that could profitably be used today.

Scientists can estimate the existence of many de-

TOTAL RESOURCES



Source: Council on Environmental Quality and the Department of State, *The Global 2000 Report to the President,* Volume One, Penguin Books, New York, 1982, p. 188.

posits of raw materials that exploration has not yet found. When the existence of such deposits has been proven then these deposits become "reserves." And, there are known deposits of raw materials that would be too difficult and expensive to mine today. When better methods of mining are developed, or the price people are willing to pay increases, then these deposits can also become "reserves."

The amount of reserves reported is part of the economic records that businesses keep. When known sources of a raw material are sufficient to meet demand for a number of years, there is no incentive or reason to explore for more. However, as demand goes up the search for more of the raw material will begin.

It is important to read reports of the availability of raw materials carefully. The amount of a known raw material that can profitably be used today will almost always be *lower* than the total quantity of that raw material. Many of the reports that indicate we are "running out" of raw materials do so because they only consider the "reserves" component of a resource. These reports consider reserves to be a fixed and unchanging amount. But "reserves" change constantly as new technology develops, exploration continues, and demand increases. Remember — these components of the resource equation directly affect availability.

HOW "KNOWN RESERVES" ALTER

ORE	KNOWN RESERVES IN 1950 (1000 METRIC TONS)	KNOWN RESERVES IN 1970 (1000 METRIC TONS)	PERCENTAGE INCREASE
Iron	19,000,000	251,000,000	1321%
Copper	100,000	279,000	179%
Lead	40,000	86,000	115%
Bauxite	1,400,000	5,300,000	279%
Phosphates	26,000,000	1,178,000,000	4430%
Oil	75,000,000	455,000,000	507%

Source: Council on International Economic Policy, Executive Office of the President, *Special Report, Critical Imported Materials* (Washington, D.C.: U.S. Govt. Printing Office, December, 1974).

Reports of reserves of raw materials vary over time. For example, on the chart on this page, the difference in reserves between 1950 and 1970 includes an increase in phosphates of over 4,000 percent (40 times as much). Note also that the amount of oil in known reserves went up by *500 percent.* During those 20 years people used millions of barrels of oil. But people also developed much better ways of finding oil and, as demand increased, so did exploration. There are still places in the world that have not been explored for oil, and there probably are rich sources of oil under the oceans. Technologies that will help us locate more oil are constantly being developed. The fact is, the total amount of oil in the ground is still estimated to be much greater than the amount of current or known reserves.

The chart at the top of the following page, developed by a group of scientists who are limits-to-growth advocates, indicates that remaining amounts of known raw materials would seem to be very discouraging. But it is important to check to see what other sources say, and to note that different predictions can be made depending on what data is used.

The second chart on the next page lists some of the predictions that have been made in the past about running out of oil and when these predictions were made. It shows that predictions of oil shortages have been made for over 100 years and have con-

POTENTIAL EXHAUSTION OF SELECTED MINERALS

RESOURCES	AVERAGE ANNUAL GROWTH IN USE (%)	YEARS REMAINING LOW	HIGH
Aluminum	6.4	33	49
Copper	4.6	27	46
Gold	4.1	6	17
Iron	1.8	154	N/A
Lead	2.0	28	119
Petroleum	3.9	23	43

Source: Adapted from Dennis L. Meadows, et. al., *Dynamics of Growth in a Finite World* (Cambridge, Mass.: Wright-Allen Press, 1974), pp. 372–73.

OIL PROPHECIES AND REALITIES

DATE	U.S. OIL PRODUCTION RATE (Billion bbls/year)	PROPHECY	REALITY
1885	.02	Little or no chance for oil in California (U.S. Geological Survey)	8 billion bbls. produced in California since that date with important new findings in 1948
1914	.27	Total future production only 5.7 billion bbls. (official of U.S. Bureau of Mines)	34 billion bbls. produced since 1914, or six times this prediction
1939	1.3	U.S. oil supplies will last only 13 years (radio broadcasts by Interior Department)	New oil found since 1939 exceeds the 13 years' supply known at that time
1947	1.9	Sufficient oil cannot be found in United States (Chief of Petroleum Division, State Department)	4.3 billion bbls. found in 1948, the largest volume in history and twice our consumption

Source: H. Kahn and W. Brown, *The Next 200 Years*, pp. 94–95. Presidential Energy Program Hearings before the Subcommittee on Energy and Power of the Committee on Interstate and Foreign Commerce, House of Representatives. First session on the implications of the President's proposals in the Energy Independence Act of 1975. Serial No. 94–20, p. 643. (Washington: U.S. Govt. Printing Office, February 17, 18, 20, 21, 1975.)

sistently been inaccurate. Why are these predictions constantly wrong? Remember the difference between a raw material and a resource. When people look only at what's in the ground, they forget the huge difference that changes in technology, society, and demand can make.

Of course, there is a limit to the amount of any natural raw material to be found on earth. But as the chart below indicates, the availability of many of the earth's resources will be adequate for a long, long time. In addition, some scientists have theories about ways to get raw materials from the moon and asteroids, and the ocean could provide enough raw materials to meet hundreds of years of demand. In fact — very few raw materials are in short supply.

NUMBER OF YEARS OF CONSUMPTION POTENTIAL FOR VARIOUS ELEMENTS

(U.S. Geological Survey Estimates of Ultimate Recoverable Resources of Materials in Top Kilometer of Earth's Crust)

ELEMENT	KNOWN RESERVES Divided By ANNUAL CONSUMPTION	U.S. GEOLOGICAL SURVEY "ULTIMATE RECOVERABLE RESOURCES" Divided by ANNUAL CONSUMPTION	AMOUNT ESTIMATED IN EARTH'S CRUST Divided by ANNUAL CONSUMPTION
Copper	45	340	242,000,000
Iron	117	2657	1,815,000,000
Lead	10	162	85,000,000
Uranium	50	8455	1,855,000,000
Aluminum	23	68066	38,500,000,000
Gold	9	102	57,000,000

Source: U.S. Geological Survey Estimates; adapted from Dennis L. Meadows, et. al., *Dynamics of Growth in a Finite World* (Cambridge, Mass.: Wright-Allen Press, 1974), pp. 372–73.

What Can We Do If A Raw Material *Does* Get Scarce?

Once again, think of the resource equation. If a raw material becomes scarce, components of the equation can change in relative importance. For instance, if the demand for a material suddenly increased, this could also increase price, which could, in turn, decrease demand. Thus, less of the material would be needed. New technologies could be developed in order to use the scarce material more effectively. Finally, society's institutions can adapt to scarcities, since people are the essence of any institution and people are adaptable.

Let's look at copper as an example of how people could easily use less of a raw material. Producers of products requiring copper could compare the cost of copper to (1) reducing the amount of copper used in their products, (2) producing their products with other materials, or (3) eliminating the need for copper in their products altogether.

For instance, copper has long been used as communications wiring because copper conducts electri-

cal impulses well. Manufacturers of copper wiring might discover a way that the wire could be made thinner without changing how well it performs. This is *conservation* — trying to do the same job using less copper and using it more efficiently.

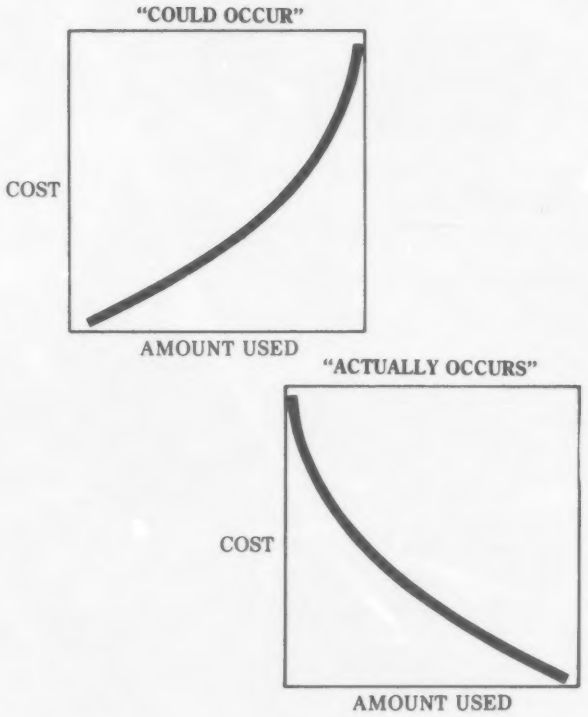
Manufacturers might decide that *substituting* glass fibers for copper wires (this is already being done by the phone company in some areas) would be cheaper and would still work satisfactorily. Or a *new technology* could be employed, like using microwaves and satellites for sending and receiving signals. This creates wireless communications, thus reducing the need for copper wiring altogether. Each of these alternatives could result in less copper being used. If copper becomes scarce enough to increase in cost, then all three alternatives might be used. If this actually occurred, people who work in the copper industry would certainly experience changes, but most people would not notice much change in their lives.

What About Price?

If a raw material does become scarce, there are several methods of allocation (deciding who can have it). If the material's uses satisfy *wants* rather than *needs*, the price will rise and the material will become a luxury. If there is a serious shortage and the material meets important needs, people may take steps to regulate or ration the material. For instance, certain materials might be regulated so that only medical industries could use them.

There are substantial scientific and economic indications that "running out" of raw materials is not going to be a problem. The total quantity of raw materials that can be made available for our use has been shown to be huge. The economic history of raw materials also shows that most of the materials used to make the products people want are becoming cheaper *relative to wages*, and more available than they were in the past.

The charts on this page show two very different ideas about raw materials. The first chart indicates that the more we use of a particular material, the more expensive it becomes. For instance, as mineral ores go from 20 percent "pure" to 1 percent "pure" (that is, more ore is needed to get an equal amount of the material) that material *should* become more expensive. But, the second chart shows what actually occurs. That is, we know that for at least 100 years the cost of many raw materials, in terms of their



price relative to wages, has come down. This is so even though we use large amounts of these materials. The fact that less of a raw material remains in the ground now than was in the ground 100 years ago can be offset by changes in the other three parts of the resource equation.

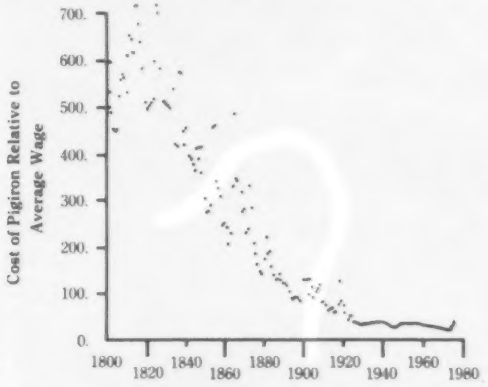
The first chart only works if everything except the "amount used" stays the same. In an industrial society changes in the other three components (technology, society, supply and demand) often occur. In an industrial society the second chart is a better prediction of real events than the first chart.

People who don't understand that resources have increased even while raw materials have decreased are liable to make poor predictions. They think that raw material scarcity and cost must increase over time. When they predict that scarcity and cost will increase in the future, they are really saying that historical trends will reverse.

Adding the three other parts of the resource equation to raw materials (and taking into account the competing ways to satisfy a demand) can actually create resources, even as the amount of the raw material itself is decreasing.

The graphs and chart that follow show that the number of hours that the average person has to work in order to be able to afford goods made from two

HISTORICAL COST OF COPPER AND IRON



Sources for both graphs: Julian Simon, *The Ultimate Resource*, Princeton University Press, 1981, p. 18 [copper], p. 349 [pig iron].

common raw materials — copper and iron — has gone down.

Consider the information presented on this issue and apply the resource equation to the question of "running out" — what is your conclusion?

Certainly, there is a finite amount of *all* raw materials. Our planet is just *so* big. But, when you consider all the facts, it simply does not appear that we will "run out" as some people think.

You may have heard of the concept "spaceship earth." This metaphor suggests that we have a very limited supply of raw materials *right now*, and when we use-up this supply, we will have no more. However, this concept ignores society's incredible ability to adapt to change and also ignores the difference between what we call "resources" and what we call "known reserves."

There are vast areas left in which to explore for minerals, and new technologies will help create substitutes for those minerals that may eventually become scarce. Using our minerals wisely is an important task. But our lifestyles will probably not be adversely affected because of any "shortage" of raw materials.

RECENT U.S. MINERAL PRICES

	1979 (Current Dollars)	1979 (Adjusted to 1982 $s)	1982 (Actual)
ALUMINUM	$ .61	$ .81	$ .76
CHROMIUM	$110.00	$146.00	$110.00
COBALT	$ 24.58	$ 32.59	$ 12.90
COPPER	$ .93	$ 1.23	$ .74
IRON ORE	$ 58.40	$ 77.44	$ 74.54
LEAD	$ 52.64	$ 69.80	$ 25.54
MANGANESE	$ 1.40	$ 1.86	$ 1.58
NICKEL	$ 2.41	$ 3.20	$ 3.20
PLATINUM	$352.00	$467.00	$475.00
PALLADIUM	$113.00	$150.00	$110.00
STEEL	$400.00	$530.40	$506.00
TITANIUM	$ 3.86	$ 5.12	$ 5.55
ZINC	$ .37	$ .49	$ .39

NOTE: Compare the middle column and the column on the right. The middle column adjusts 1979 prices (by applying the Consumer Price Index) to reflect what these materials would have cost in 1982 dollars. The column on the right is actual 1982 costs. Prices are per customary unit of quantity. These price trends were affected by poor world economic conditions during this period.

For example, the cost of copper went down by .49¢ (1.23–.74) — or 40% — from 1979 to 1982. During the same period, though, average wages rose, even in constant dollars. As you can see, this is the case for most minerals.

SOURCE: U.S. Bureau of Mines, *Minerals & Materials: A Bimonthly Survey*, February/March 1983.

RESOURCE ISSUE 2: WILL THERE BE ENOUGH ENERGY?

Something unusual happened in 1973. Many of the Arab nations that supply much of the world's oil decided to stop shipping oil to the United States. They did this as a protest against political decisions that the United States had made. This policy became known as the "Arab Oil Embargo."

The United States depends heavily on Arab oil to make gasoline and other products. So, when the embargo was put into effect, people panicked. Long lines soon formed at gas stations in order to buy the gasoline that was available, people and companies tried to store as much oil as possible, and prices of gasoline and oil-based products rose quickly.

Many people viewed this situation as the "beginning of the end." They felt that the world was running out of energy, so oil would now be used as an economic "weapon."

These people were overlooking some very important points. First, oil is only one form of potential energy. Energy is a means of producing some action, of getting something done. There are many other forms of energy that can get things done, too. Second, Arabs not selling oil is *not* the same as running out of oil; they still had the oil in the ground. Third, since the countries in the world are interdependent, the U.S. had things that the Arab nations wanted. Fourth, while the embargo created a temporary crisis, people are very adaptable and can "rise to the occasion" — the embargo created the incentive to conserve oil. Finally, new technologies were developed in response to the discomfort that the U.S. felt as a result of this energy shortage.

All of these things illustrate how the resource equation works. When the oil embargo occurred and there was a shortage of gasoline supplies, the demand for gasoline rose. However, in response to this demand, increased prices soon led to conservation. So *demand* eventually went down. *Society* reacted by instituting new policies that would reduce the need for oil, and new *technologies* were introduced. This alleviated some of the burden as well. Once again, as one component of the equation changed (in this case there was a *temporary* shortage of the raw material oil), the other components changed too.

There are many forms of energy that we rely on. Oil is just one raw material used to produce energy. However, oil is very important to the world's economy and it receives much attention in the news. We will study oil a bit further in order to understand the difference between temporary shortages and actually running out (recall the chart on page 78!). Later in this section you will see a list of many ways of producing energy that do not require oil.

The oil embargo is not an example of "running out." Instead, it is an example of a geopolitical and social problem. Geopolitical problems are problems created by geography and politics, while social problems are problems created by the laws and the choices made by society.

Every nation is dependent on other nations for some of its resources. This means that every nation has something to lose by cutting off or damaging its relationship with other nations. The chart below shows that the four countries that supply the most oil to us buy important items from us, too.

THE UNITED STATES IMPORTS CRUDE OIL FROM MANY SOURCES. THE FOUR MAJOR SOURCES IN THE SUMMER OF 1982 WERE (in order):

COUNTRY	MAJOR EXPORTS FROM U.S. TO COUNTRY (by $/year)
1. Mexico	Road Vehicles, Specialized Industrial Machinery, Cereals
2. Saudi Arabia	Industrial Machinery, Power Generating Machinery, Road Vehicles
3. Nigeria	Cereals, Specialized Industrial Machinery, Manufactured Goods
4. United Kingdom	Aircraft, Spacecraft & Associated Equipment, Office Machines & Data Processing Equipment, Nonferrous metals

If a nation decided to quit producing or selling a raw material, then reserves from other nations could be used instead. Shortages of the raw material could create temporary problems. But the U.S. experience with shortages during World War II showed that people can adapt and "make the best of it."

An example of a resource problem of a social nature is the fact that for many years United States laws kept the price of oil produced in the United States lower than the price of oil produced in other countries. This meant that people in the United States paid less than the real "market price" for gasoline. So, when gasoline was cheap, cars were made that used gasoline inefficiently, and people used a lot of gasoline. Social problems are solved the same way

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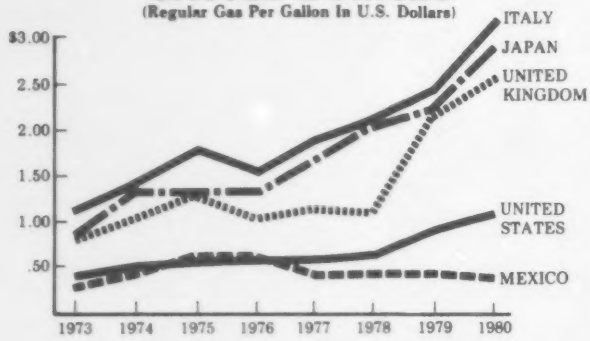
they are created — people in a society choosing the laws and policies they want.

Increases in the price of oil sold to us by other countries encouraged us to become more efficient users of this material, to invest in research on alternative energy sources, and to allow the price of our own oil to rise to the market price level. These actions served as *countervailing forces* to the past trend of a constant increase in the amount of oil that we used. The trend of increasing consumption is changing long before the raw material oil becomes scarce.

GASOLINE PRICES

(Regular Gas Per Gallon In U.S. Dollars)



Basic Data: *International Petroleum Annual* and *Monthly Energy Review*, as compiled by the Energy Information Administration.

In the case of oil, the geopolitical and social problems that we experienced led to renewed examination of a much larger question: will there be enough energy available in the future to create the comforts we are accustomed to?

In order to answer this question, scientists and economists did exhaustive research in *many* energy areas. Let's stay with the oil example, though.

Four pieces of data are presented to help answer the question. This data covers components of the resource equation — specifically, 1) how much of the raw material oil is available, 2) what society has done to ensure that oil will be available, 3) the role that computer technology plays in providing us with oil, and 4) the demand for and price of oil.

The chart on the World Oil and Gas Resource Base indicates that only a fraction of the total oil and gas resource base has been used to date.

The next chart (Reactions to the Oil Embargo) illustrates the second point: some of the many things that society is doing to ensure that oil lasts as long as possible.

The last graph on the page illustrates the third

WORLD OIL AND GAS RESOURCE BASE (1981)

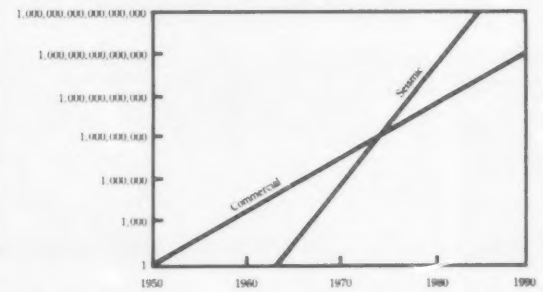
	Billions of Barrels Oil Equivalent*
Remaining Proved Reserves	1000–1200
Probable Reserves	300–600
Total Remaining Commercial Reserves	1300–1800
Cumulative Production to Date	700
Total Resources Discovered to Date	2000–2500
Undiscovered Potential	1000–2500
Total Oil and Gas Resource Base	3000–5000

*Includes crude oil, natural gas expressed as its energy equivalent in oil, and liquids removed from the gas.
Source: Exxon Corporation "How Much Oil and Gas," May, 1982, p. 10.

REACTIONS TO THE OIL EMBARGO

- U.S. Government requires cars get better fuel economy (more miles per gallon)
- Tax Credits for people who insulate their houses
- Conservation — Americans use less and less gasoline
- Tax incentives for installing solar devices, and being in the energy conservation business
- U.S. increases its "stockpiling" of oil and other critical minerals
- Companies invest huge amounts of money (capital) in the development of new energy technologies
- Synthetic fuels — replacements for oil — are studied and developed
- More electric cars and solar-electric cars are built

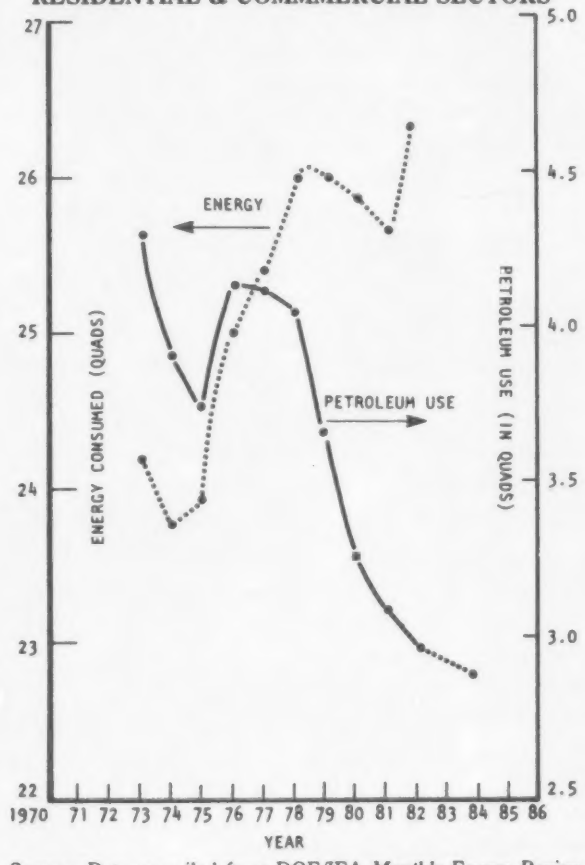
THE EVER-GROWING COMPUTER POWER



Note: The seismic computers referred to in the above figure are ones which have been and are being designed for the specific high speed "number crunching" tasks required in processing the data produced by the large arrays of seismometers routinely used in oil exploration.

Source: Carl H. Savit in *Petroleum 2000*.

TOTAL ENERGY & PETROLEUM CONSUMED IN THE RESIDENTIAL & COMMMERCIAL SECTORS



Source: Data compiled from DOE/IEA *Monthly Energy Review* issues.

NOTE: Read the column axis at left (22–27 quads) to determine total energy use. Use the column axis at right (1.5–5.0 quads) to determine petroleum use.

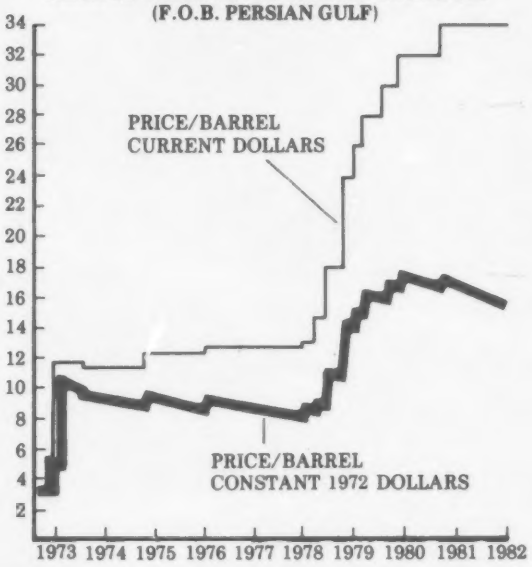
part of the equation. The power of computing (the capacity of a computer to deal with information) is increasing exponentially. This expanded power, especially when applied to seismology (the study of earthquake phenomenon), helps scientists locate more oil. This is but one of many examples of how new technologies will help to ensure a long-lasting supply of oil.

Finally, the graphs on this page show (1) that our use of oil (petroleum) has been declining, while our total energy consumption has been increasing and (2) that the *real* cost (the cost in *constant* dollars when adjusted for inflation) of oil has not risen as much as many people think.

The notion that the oil crisis meant the end of energy supplies provides a good example of why you must always seek the "big picture" when predicting

REAL COSTS

PRICE OF SAUDI ARABIAN LIGHT CRUDE OIL (F.O.B. PERSIAN GULF)



SOURCE: *Petroleum Economist,* as compiled by W. M. Brown.

the future. Studying energy issues is important. We will need to continue to develop new ways of meeting the world's energy needs, we will need good energy policies, and we will need to seek ways of avoiding future geopolitical and social problems. There *is* a finite amount of any non-renewable raw material, and oil is no exception. But we will *not* run out of oil very soon, and oil is only one form of potential energy anyway.

The oil crisis called our attention to the energy issue. It taught us some valuable lessons; it taught us to conserve, to explore new technologies, and to be aware of our energy future. Perhaps a good perspective to use with regard to this issue is presented in the following quote:

> "There is general recognition that the oil crisis and subsequent events represented an energy watershed, but it was not a watershed from abundance to scarcity, or even from cheap to expensive, but rather from cheap to inexpensive. That is, many in the industrialized world will continue to drive large cars if they like them, live in big houses, over-heat and over-air condition their homes, expand suburban sprawl, use electric signs and street lighting lavishly, and continue other high energy-consumption activities. But it also seems quite clear that more care will be exercised —

that some will switch to smaller or more energy-efficient cars, homes will be better insulated, more efficient lighting, heating and cooling systems will come into use, and so on. Thus the functions that used energy so lavishly in the past will continue to be performed with relatively little change, but there will be considerable change and improvement in the efficiency of the means of performance." *

The answer to the question — will we have enough energy? — involves much more than just the oil example that you have been studying. For one thing, there is enough coal in the world (especially in the U.S.) to meet the demand for energy for many years. And we can generate much of our electricity by "natural" (non-exhaustible) means by using water flow, solar radiation, and wind. Some of these so-called "alternative" energy sources are not economically competitive now; however, as the price of conventional sources rise, they will become more viable.

The chart that follows lists some forms of energy and energy technologies that are "unconventional," but that are the subject of much current research and experimentation. These long-term sources will ensure that you need not worry about whether or not there will be enough energy in the future. We have a Scotch Verdict about that.

THE TRANSITION TO LONG-TERM SOURCES OF ENERGY

SOURCE	EXPLANATION
Wind Electric Power	To be obtained from strategically placed arrays of large modern windmills
Bio-Conversion	Energy obtained by converting organic materials, especially wastes, to fuels or electric power
Solar	Direct heating and cooling of buildings using solar radiation (the sun) as a heat source
Photovoltaic Power	Conversion of sunlight to obtain direct-current (DC) electricity
Ocean Thermal Power	Conversion of solar radiation to heat and steam that drives electric power generators
Geothermal	Energy (heat) contained within the earth
Nuclear Fission	Atoms in the elements uranium or plutonium are split
Nuclear Fussion	Atoms of the element hydrogen or combined, or fused, to form an atom of the element helium

Adapted from *The Next 200 Years.*

*Kahn, Herman, et. al. *The Next 200 Years,* William Morrow and Company, New York, 1976, p. 59.

RESOURCE ISSUE 3: WILL THERE BE ENOUGH FOOD?

"Two-thirds of the world's people go to bed hungry every night." So said Lloyd Belacourt, the Director of the United Nations Food and Agricultural Organization (FAO), in 1950. Yet, in 1969, this same organization stated that future problems with food would probably be ones of *surpluses*, not shortages.

According to recent data, between 12% and 20% of the world's population is undernourished.* But the number of people who actually go to bed hungry every night certainly is nowhere near two-thirds of the earth's population. Nevertheless, many people still believe this to be the case.

We know that many people starve every year, and that many more people are malnourished. Therefore, some people come to the conclusion that there just isn't enough food for everyone. And, these people also point out that the earth's population is increasing. Food is certainly a very critical resource.

When you go to the supermarket today you have many choices. There's always fresh meats, vegetables, and fruits available. There is an even greater variety of canned and frozen goods. So, your choices are not usually limited by what's available, they are limited by how much money you can spend (or want to spend) on food.

This was not always the case. Even in the United States, where we have good land and good climate for growing food, people did not always have so many food choices. Less than 75 years ago we did not have adequate ways of transporting or storing foods. Back then, people mainly ate those foods that were produced locally.

With the construction of modern highway, rail, and air freight systems, the development of refrigerated transport, and the use of sophisticated agricultural production and processing techniques, more food became available to more people. Now we can enjoy fruits and vegetables "out of season," fresh meats and poultry are in plentiful supply, and even very exotic, imported foods are readily available.

So, why do some people starve?

There is sufficient food produced each year to feed all the people in the world. Food production has become very sophisticated and we now can produce "more from less." According to the Department of Agriculture, for example, more than 90% of the U.S. population in 1790 was needed to produce enough food; today, about 3% of the population is employed on farms. This 3% can not only produce enough food to feed more than 200 million Americans, they also feed much of the world's population through food exportation and aid donations.

The reason people starve is not that there isn't enough food. People starve because of economic and political reasons and because of problems of distribution.

According to the United Nations, worldwide per capita food production (the amount of food produced per person) has risen about 1% per year since 1960. This led to the production of more food in 1982 than in any year in history. In fact, many of the industrialized countries have huge surpluses of food. In the United States the government even pays farmers *not* to grow food. In 1983, almost 25% of all our country's major field crops went unplanted!

WORLD GRAIN PRODUCTION

Year	Millions of Metric Tons	Yield: Metric Ton per Hectare (abt. 2½ acres)	Kilograms per person
1950	631	1.05	251
1960	863	1.26	285
1970	1137	1.62	309
1980	1440	1.90	335
1981	1620	2.13	365

Source: United Nations Food and Agricultural Organization Yearbook, 1982.

Producing its own food is one way a country can get this resource to its people. Another way is trading with countries like the U.S., Canada and Brazil, that produce food for export.

Those countries that have not been in the industrial stage of the Great Transition for very long (the "developing" countries) typically have far more problems supplying their population with food than industrialized nations do. Some developing countries do not yet have advanced agricultural techniques and/or do not export enough goods to buy adequate supplies of food in return. But this is changing.

Remember the "rising tide" idea? This concept can be applied to food supplies too. As a super-industrial country develops a new agricultural tech-

**World Development Report*, 1982, World Bank.

nology, that technology can be utilized by developing countries. And, as the world economy grows, so do the economies of most of these developing countries. This creates goods for trade, and makes more money available for food production and food purchases.

Let's look at how some of these developing countries are progressing. The first chart shows changes in food production. As you can see, per capita food production is increasing worldwide, even in the low and middle income countries. Keep in mind, though, that this does not mean that every country is experiencing this increase. These figures are averages for all countries in each category. Some countries, particularly some of the lower income countries, have actually had declines in their per capita food production. These declines are often the result of climatic problems, government instability, rapid population growth, or war. But there has been an overall increase in world food supplies.

CHANGES IN WORLD FOOD PRODUCTION

	Population	Food Production per Capita 1978–80 Change From 1969–1971
Low Income Countries	2,160.9	+6%
Middle Income Countries	1,138.8	+8%
Industrial Market Countries	714.4	+11

Basic Data: *World Development Report*, World Bank, 1982.

Many of the low income (developing) countries are growing economically and are increasing their exports, too. This growth will give them the opportunity to buy more food. But, as the business people and government leaders of these countries experience greater economic opportunities, they must make the choice between buying food or buying other items. The charts that follow show the rates of economic growth for some of these developing countries. They also illustrate the relation between overall economic growth and the ability to produce food.

As you read earlier, food is a very critical "resource." So, the resource equation can be applied to food, too. In this case, the *raw material* components are land for growing, water, sun, and seeds to plant. The *society* components are the way the agricultural

EXPORTS OF MANUFACTURED PRODUCTS BY 37 DEVELOPING COUNTRIES

GROWTH RATE OF EXPORTS, 1972–78*

LESS THAN 7%	7%–13%	MORE THAN 13%
Colombia	Bangladesh	Chile
Dominican Rep.	Costa Rica	Cyprus
Egypt	Ivory Coast	Haiti
El Salvador	Kenya	Indonesia
Guatemala	Turkey	Jordan
Pakistan	Argentina	Macao
Yugoslavia	India	Malta
Mexico	Israel	Mauritius
	Hong Kong	Morocco
		Peru
		Sri Lanka
		Tunisia
		Uruguay
		Malaysia
		Philippines
		Thailand
		Brazil
		Singapore
		Korea
		Taiwan

Source: *OECD Observer*, November, 1982.

FARM PRODUCTION GROWTH RATE AND RATE OF ECONOMIC GROWTH (GDP) OF DEVELOPING COUNTRIES

AVERAGE ANNUAL RATE OF FARM PRODUCTION GROWTH	AVERAGE ANNUAL ECONOMIC GROWTH		
	ABOVE 5%	3%–5%	BELOW 3%
ABOVE 3%	China Colombia Indonesia Kenya S. Korea Malaysia Philippines Thailand Turkey	Burma Tanzania	—
1%–3%	Egypt	Bangladesh India Pakistan Sri Lanka Sudan	Zaire
BELOW 1%	Morocco Nigeria	—	Ethiopia Ghana Mozambique Uganda

Source: *World Development Report,* World Bank, 1982.

system is organized, farm labor, financial systems that loan money to farmers and shippers, the road systems — what is called the *infrastructure* of society. The *technology* components include farm machinery, food storage equipment, food processing equipment, fertilizers, pesticides, agricultural research, and the development of completely new sources of food, to name a few. *Supply and demand* are obvious — everyone needs to eat and, a country's food supply is related to its demand.

So, what will the future be like when it comes to food supplies? Surely, there will be enough food produced to feed the world's population and, just as surely, economic, political, and distribution factors will still cause problems. In the future you will probably eat most of the same foods that you eat now. There will be some changes, though.

In the U.S. you are likely to see more and better "convenience" foods. This will include even more full meals packaged in a way that makes them easy to store, cheap to buy, and simple to prepare. You will see new packaging techniques, such as the use of cardboarded rather than canned goods. You will see foods made from substances that you have never even heard of (have you ever eaten foods made from *quinoa?*)

Finally, the future of food supplies will be largely affected by the development of new technologies. Breakthroughs in *genetic engineering* could create plants and animals that could substantially alleviate the food problems that exist in some countries; *aquaculture* (growing plants in and under water) could do the same. Scientists are also learning how to make better fertilizers, exercise control of climates, irrigate using less water, control pests, and grow things productively in deserts where this was once impossible.

There will be enough food in the future. However, world and national leaders need to figure out ways of getting it to where it is most needed.

RESOURCE ISSUE 4: WILL WE MAKE GOOD DECISIONS ABOUT OUR ENVIRONMENT?

Everyone, particularly our leaders, are stewards of the environment. A steward is someone who manages another's property. Since the environment belongs to everyone, decisions that affect the environment affect everyone's property.

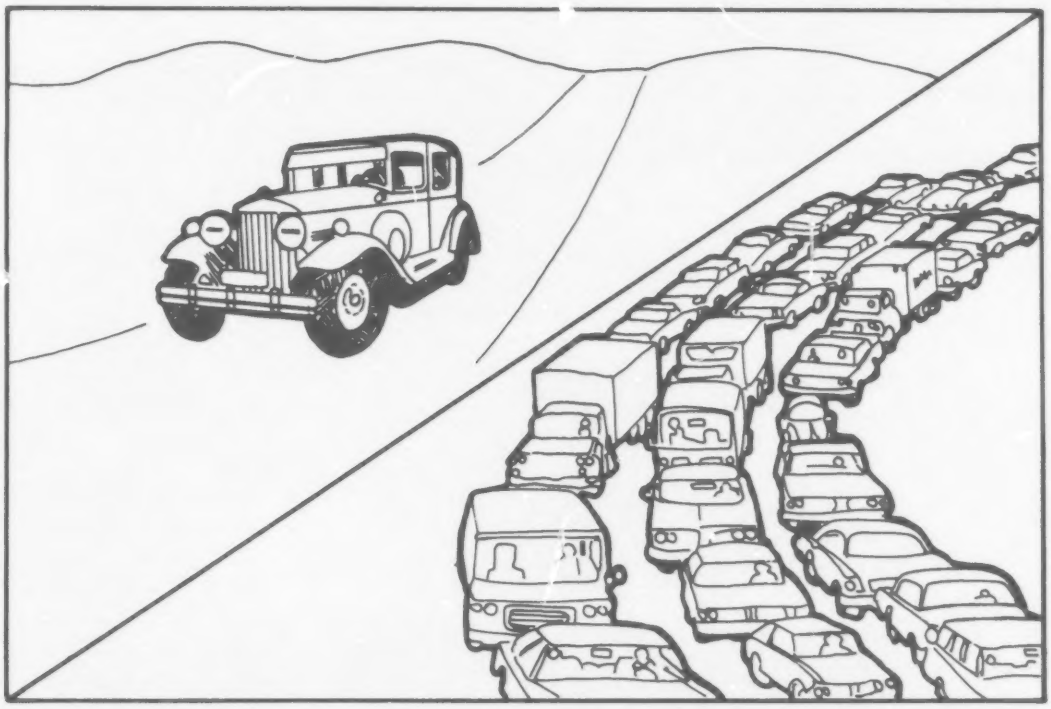
The debate that surrounds the use of our environment is very passionate. Some people feel that we should not do something if that action has *any* negative impact on the environment (the most extreme case made by "limits to growth" advocates). Other people feel that we can use our environment without any concern for the consequences. These are the extreme cases in the debate over the environment.

The environment is also a "resource." It too is affected by each of the components of the resource equation. As each component changes, the other components are affected. Being able to make good decisions about the use of our environment — being a good steward — starts with an understanding of some concepts that many people overlook. These concepts include *externalities*, *tradeoffs*, and *creative destruction*.

Externalities

Human beings keep looking for better ways of doing things. There always are some people who want to improve a machine, an idea, or a process. These people get dissatisfied with the way things are, and act to change the situation. Some changes, such as cures for diseases, safety inventions, and improvements in agriculture have had positive human consequences. Other attempts at change have produced wars, pollution, and other negative consequences. Although most changes probably begin with good intentions, they usually have both good and bad results.

An example of a new idea (or innovation) that has had both good and bad consequences is the use of the raw material coal as an energy source. Coal can be burned to make electricity. This results in



When cars were invented, most people realized that they would create better transportation and new jobs. But not many people predicted the negative *externalities* that cars produced, such as traffic jams and air pollution.

benefits such as being able to heat or cool buildings at a relatively low cost and the creation of jobs for coal miners. Unfortunately, a coal mine can make a landscape unattractive. All these were understandable and predictable effects.

The problems associated with coal as an energy source arose from other results that were less predictable. The waste products from burning coal made the air unhealthy in some places and reduced how far people could see; scientists also discovered that burning coal may also result in rain water becoming more acidic than normal.

Unpredicted results, which can be either helpful or harmful, are sometimes called *externalities*.

> POINT TO PONDER: Societies have built huge dams in order to both store water and generate electricity via hydroelectric power. What are some effects of "rearranging" nature in this way?

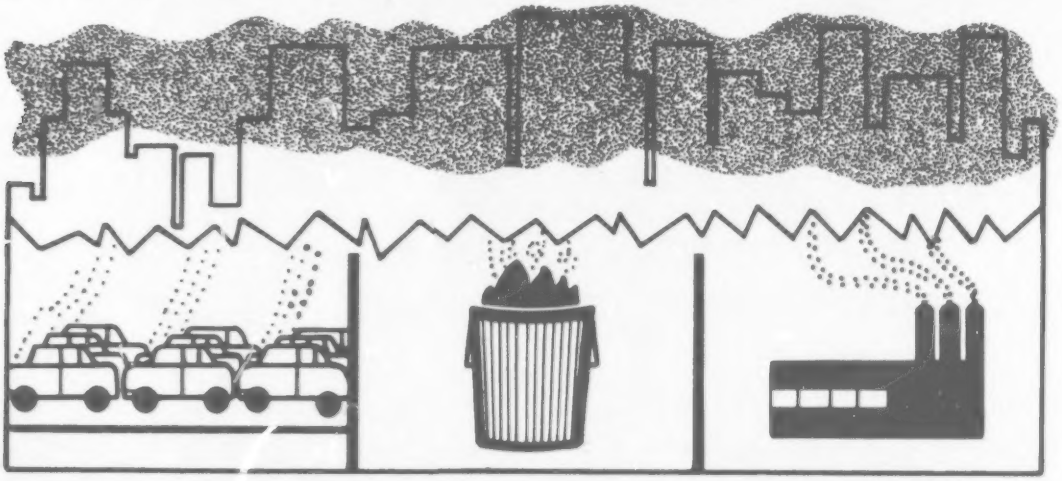
Since large projects usually have more positive and negative impacts than do small ones, and since we have many large projects today, we are constantly discovering externalities. However, if externalities are discovered soon enough, something can usually be done to correct the problems they cause.

Consider, as an historical example, the many pollutants that major U.S. cities had in their air 30 years ago. The major sources of the pollutants were incinerators in backyards for burning garbage, large industrial plants, and automobile exhausts. However, each of these sources of the problem also created benefits for people. People didn't have to pay for garbage pickup if they had incinerators. Industrial plants provided many jobs and products people wanted. Automobiles were fun and convenient. But the externality of air pollution was extremely negative. The air in Los Angeles, for example, became so dirty that it made it difficult to see and caused some people to experience sinus problems.

People in the major cities considered both the good and bad effects and decided to try to reduce the air pollution. The first thing that many cities did was to pass a law stopping all burning of garbage. Air pollution became less of a problem after that, and many jobs were created by private and public garbage collecting services.

Even after backyard incineration was stopped, the air in most places was still too dirty. Next, industries were required to install equipment to keep most of the pollutants inside the smokestacks. The air got cleaner, but people who bought products from those industries had to pay a little more to cover the cost of the pollution control devices. Industries that couldn't be competitive because of the new pollution control costs went out of business.

Finally, since many people wanted still cleaner air, something was done about the pollution caused by automobiles. Cars were required to have special equipment and to use unleaded gasoline so that fewer pollutants would be released. Air became cleaner but the cost of cars went up, as did the cost of this special fuel. As a result of these actions, nearly all major U.S. cities have cleaner air today than they did 50 and 100 years ago, even with larger populations.



Problems ⇨ SOLUTIONS

When people can see who or what is causing a problem, there usually are several ways to correct the problem. Depending on the situation, society can employ various ways for correcting externalities, including taxing, subsidies, court-ordered payments, and regulation, to name a few. All of these corrections are based upon knowing the source of the problem. The most difficult externalities to correct are the ones where no one cause can be identified.

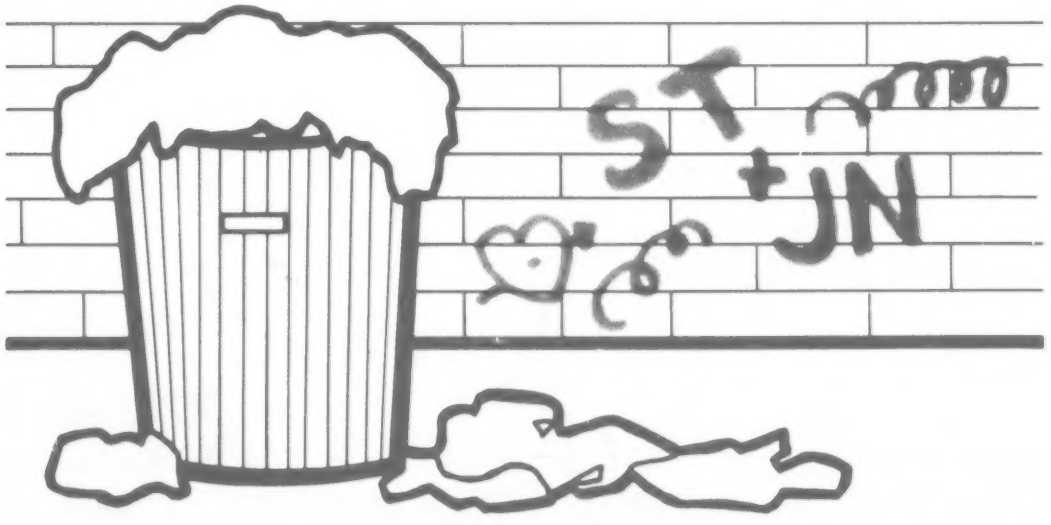
Garrett Hardin coined the phrase "Tragedy of the Commons" to explain what happens when all people share something of value but no one takes responsibility to care for it. We see this occur everyday when we notice public buildings and public facilities that are harmed in various ways. School restrooms are a good example. They are often abused and no one source of the abuse can be found. The tragedy is that everyone uses the restrooms, so no one feels responsible for them. Another example is when people or businesses dump waste into lakes and rivers. Each source may seem small and unimportant by itself. But together, these waste products can damage a lake or river to the point where fish will die and people can't use the water for swimming or drinking.

If problems are recognized early enough, and people are willing to pay for their solution, something can usually be done about them. Lake Erie was once considered "dead" because of pollution, but now has lots of fish and is used for recreation. But people had to pay a lot of money to restore this "resource" and they no longer have such a convenient way to get rid of wastes.

Tradeoffs

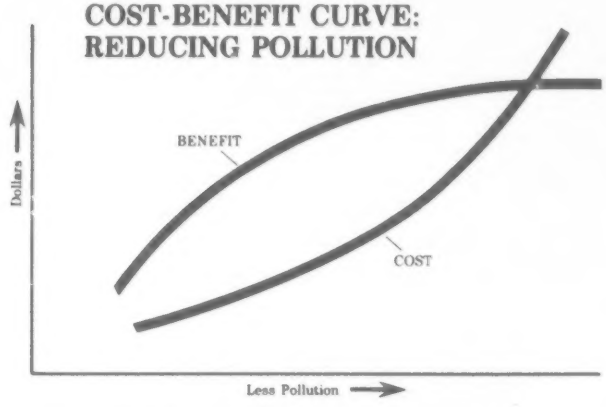
People differ on how much money or convenience they will trade for something they all hold in common. For instance, some people want undisturbed wilderness areas more than they want the coal that can be found in such areas. The *tradeoffs* they might make in this case could include paying for energy conservation or having colder buildings so that less coal would be used. Or, they might choose to use more oil and less coal. Which tradeoff to choose depends upon many different things and people often disagree on what the best tradeoff is. An "environmental impact statement," which often is required for large projects today, provides data for making informed decisions on tradeoffs.

Because of the number of different projects and the size of projects today, nature is no longer able



to keep the air and water completely clean through natural cycles alone. However, we have developed special technologies devoted to cleaning the environment. Our society has chosen to continue to have projects that create air and water pollution, and also to pay the costs of reducing pollution at the sources. In an affluent society like ours the costs of controlling pollution are relatively low. However, there is still much disagreement on the amount of pollution control and cleanup that society should require. The graph below shows that at some level of pollution control the costs will be higher than the benefits. It is very hard to decide when the additional costs will be higher than the additional benefits.

COST-BENEFIT CURVE: REDUCING POLLUTION



Sometimes disagreement about tradeoffs is based upon different ways of interpreting the same data.

For example, one reason for concern about air pollution is that it can affect people with lung diseases. Studies have indicated that when air quality is bad, people with lung diseases suffer more. However, there is disagreement concerning the level of air pollution that it takes for people to become more likely to get various diseases.

Consider two different ways of looking at the data related to this issue. The number of people who get lung disease in polluted areas can be compared to the number of similar people who get lung disease in non-polluted areas. The difference is the number of people who probably get sick because of air pollution. Another way of looking at this same data is comparing the number of people who get lung disease in an area to the total number of people in that area. People have different reactions to these two statements: 1) "over 126,000 people in the U.S. die each year of lung disease;" 2) "less than .0006% of the U.S. population dies of lung disease." Yet, both statements are accurate and are based on the same data.*

**Vital Statistics of the U.S.*, Vol. II, Mortality, Part A, 1978, Table 1–7, pp. 1–76.

EXEMPTION TO CLEAN-AIR LAW DEBATED FOR 'DIRTIEST' PLANT

DOUGLAS — In a battle of clean air vs. jobs, Douglas residents Tuesday backed the Phelps Dodge Corp. copper smelter here, while what the city's mayor termed "outsiders" called for the closure of the state's oldest and, by state figures, dirtiest smelter.

At a hearing on whether the Phelps Dodge smelter can continue to receive state and federal exemptions to pollution laws, Douglas residents unanimously backed allowing the 69-year-old smelter to continue emitting up to 1,100 tons of sulfur dioxide each day.

City residents told an Arizona Department of Health Services official conducting the hearing that the smelter smoke, while sometimes an eyesore, is vital to the Douglas economy. They pointed to the 400 jobs the smelter now provides in this border city of 13,000 people.

Residents referred to statements by Phelps Dodge officials, who have said for years that rather than install multimillion-dollar pollution equipment — a step they say is economically unfeasible for the old smelter — they would shut it down.

But a majority — all of them from outside Douglas — of the approximately 35 speakers at the hearing condemned continuation of the exemptions. These opponents said the smelter smoke is a health hazard to humans in Douglas and other communities miles away as well as a threat to crops at farms in the Sulpher Springs Valley north of Douglas.

Of the seven Arizona copper smelters, only the Phelps Dodge Douglas facility and Magma Copper Co.'s San Manuel smelter have applied for the exemptions.

Magma is intending to install additional pollution-control equipment to remove about 90 percent of the sulfur dioxide from the San Manuel smelter smoke, as other Arizona smelters have done or are in the process of doing.

Smelter workers asked state officials to "keep us off welfare" by granting the exemptions and keeping the smelter open, while opponents centered on the theme that the smelter has been polluting long enough and that the potential health hazards must come to an end.

Reprinted with permission from *The Arizona Republic*.

People also disagree about how much pollution control should be required at industrial plants where metal is refined. The newspaper article on the previous page gives an example of the tradeoffs between pollution and jobs.

The example of disagreement about how much pollution control should be required of metal refineries involves data on jobs as well as health. The price of metal will increase as pollution control devices for this industry are required. When prices increase, fewer people may buy the metal product. So increasing pollution control could mean that less metal would be produced and that fewer workers would be needed. There are several ways this data could be presented. The statement could be made that "as a result of pollution control requirements at the metal refinery 250 people lost their jobs," or it could be said that "the state's unemployment increased by .01%." It also could be said that "the town's unemployment doubled."

POINT TO PONDER: If you were arguing for requiring more pollution control which statements would you use? If you were arguing for buying less pollution control, which statements would you use? Which statements do you think "limits to growth" advocates use? Which statements are used by people who don't feel that we need to limit growth?

Another way of presenting data is to compare various risks we experience. The statement could be made that working with asbestos increases an individual's risk of dying of lung cancer by over 400%. Yet smoking increases the risk of dying of lung cancer by over two times the amount that working with asbestos does.

LOSS OF LIFE EXPECTANCY DUE TO VARIOUS CAUSES

CAUSE	DAYS
Cigarette smoking - male	2250
Being a coal miner	1100
Being 20% Overweight	900
Motor vehicle accidents	207

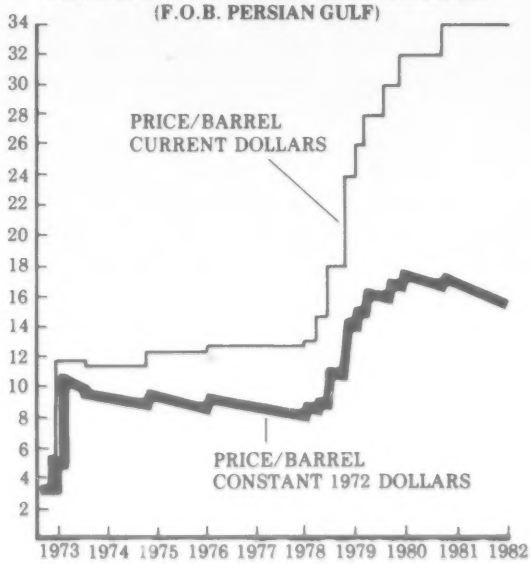
Another way of presenting this health data would be to examine how many years of life were destroyed by certain actions. If people do not die of lung disease, then they will die of some other cause. The average person's length of life is decreased by approximately three years (1,100 days) by working in a coal mine. The average male's length of life is decreased by more than six years (2,250 days) by smoking.

POINT TO PONDER: If smoking causes much more lung disease than asbestos how should our government react to each cause? Do you think that smoking and asbestos should be treated differently?

Data can sometimes be misleading because only the current amount is given. Someone could say that 1,000 Americans died in 1900 and 2,000 Americans died in 1950 from a particular disease. What has not been said is that there were twice as many Americans in 1950 as there were in 1900. This means that even though the number of deaths increased, the seriousness of the problem did not. The percentage of the population dying from the disease is the same in both cases.

REAL COSTS

PRICE OF SAUDI ARABIAN LIGHT CRUDE OIL (F.O.B. PERSIAN GULF)



SOURCE: *Petroleum Economist*, as compiled by W. M. Brown.

A similar problem is often encountered when dollar amounts are discussed or reported. It is im-

portant to consider the cost of something in *constant* or *real* dollars. In recent times the amount of goods and services that $1.00 can buy has decreased each year due to inflation. So, if something sold for $10.00 in 1970, and for $10.00 in 1980, the *real* cost decreased.

> POINT TO PONDER: Look at the chart *Real Costs* on the previous page. (You saw it in the "Energy" section too.) Between 1974 and 1977, did the price of oil increase or decrease?

Different ways of stating facts can make big differences in the decisions people make. It is very important to look at how facts are stated when examining resource and environmental problems.

Industrial and pre-industrial societies have different attitudes about resources and the environment. Avoiding starvation and accidents, and not getting sick were often daily struggles for people in pre-industrial societies. On the other hand, large increases in wealth, population, and control over the forces of nature have allowed industrial societies to take action on even the most complicated health issues. Some industrial societies can even afford to do something about the problems of starvation and disease in *other* societies.

Resource and environmental issues are different in different stages of society. The biggest problems for people in most pre-industrial societies are not producing enough food and not being able to survive injuries. Pre-industrial societies have fewer resources available than industrial societies do. So, pre-industrial societies may have to use common plants or animals for many purposes. For instance, instead of heating a house by natural gas or electricity, animal furs and fires may keep people warm. With fewer resources fewer things can be done to keep people healthy and comfortable. In pre-industrial societies people can die of exposure to the cold or heat, or be constantly unhealthy due to malnutrition. For pre-industrial people, the major resource and environmental issues are simply their concern with staying alive.

When societies industrialize, a wide variety of resources are made available. People become more concerned about finding cheaper ways to provide resources than they are about finding enough resources. Many more wastes (byproducts of resource use) are created because of increased use of resources and increased population. These increased wastes often result in poor sanitation and the spread of disease.

> POINT TO PONDER: Which would be less healthy: a city with 50,000 horses, or a city with 50,000 cars?

In the super-industrial stage of industrial society environmental issues become very important. The long term environmental effects of many large projects, such as nuclear power plants, are often unknown. Resource and environmental issues in this type of society often include discussion of how to best use the raw materials that are available so that they will continue to be productive. This is usually a discussion about tradeoffs.

When societies begin to become post-industrial, people's attitudes about resource and environmental problems will likely change. Most people in the post-industrial society will be affluent and value the environment more for recreation or beauty than for economic growth.

Creative Destruction

The use of forests in the United States is a good example of how changes in the use of a raw material (trees) can create environmental problems. During the 18th century, the Plains Indians deliberately set fire to the western edge of the great eastern forest in order to increase grazing land. What this pre-industrial society gained in extra food (from having more grazing land) seems to have outweighed whatever was lost to them by burning the forest.

Europeans who settled the eastern United States cut down trees to get lumber for homes, wood for heating, and space for farming. When this is done on a very large scale without replacing what is cut down, it is called "deforestation." Unfortunately, deforestation can cause serious soil erosion and flooding.

You can see that there are tradeoffs here. For these societies, there clearly were benefits from cutting down and burning the forest and from converting the forest to grazing land, farming land, and space for cities. Everyone assumed the gains were more important than the losses. Looking back, most of us would generally agree. This is an example of a process called *creative destruction*. In this case, the destruction of parts of the forest created a better life

for millions of people who immigrated to the U.S. and for their descendants — probably including yourself. If the deforestation efforts had an effect on the climate (an externality), it hardly seems noticeable.

However, the amount of forest that was destroyed in the eastern half of the United States during industrialization certainly did have some harmful effects. For example, it contributed to serious flooding problems in the great river system of the Midwest. These floods have been costly to control, and you hear news reports about floods in this area almost every spring. And, flooding itself causes more soil erosion and loss of farm productivity. Some of this soil washes down the Mississippi River and ends up creating new land near the city of New Orleans. This may have some good aspects, but it creates even more flooding problems in that area and requires costly dredging of shipping channels.

However, because industrial societies (particularly those in the super-industrial stage) can be so efficient at producing and transporting food, less land may be needed for farms. Therefore, some places actually have much *more* forest land now than they did one hundred years ago.

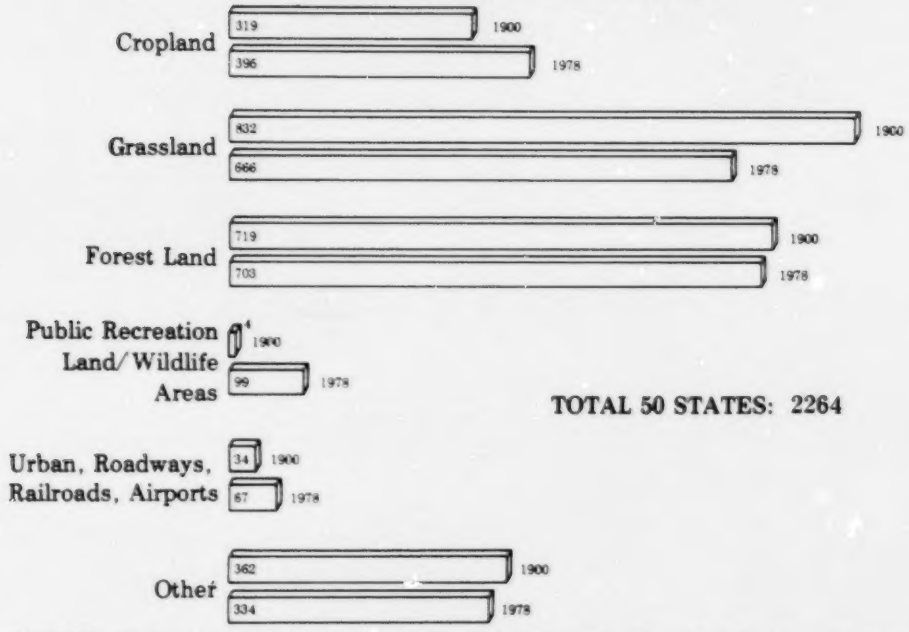
The Northeastern United States is an example of an area where great stretches of forest now exist on land that used to be farms. This can be seen when one flies over the area. There are many stone walls now overgrown with greenery; they were once used to separate farms. These farms became unnecessary and not profitable because basic industrial technologies (e.g., refrigerated transportation of produce) enabled produce grown in more productive areas, like California, to reach the markets that the Northeastern farms were selling to.

The United States today creates less deforestation than in the past because there is more knowledge of how to manage and restore trees as a crop. Some U.S. forests are protected in their natural state, too. Protection of forests is an example of post-industrial attitudes towards the environment. The chart on the next page shows that U.S. wildlife areas and recreation lands (much of which are forested) have increased greatly since 1900.

Deforestation has also reduced the total number of plant and animal species or, at least, caused them to "retreat." Yet, forests have sprung up in former farming areas and some formerly endangered animal species are now beginning to increase in number. Deer and raccoons have actually become a nuisance in the suburbs of many northeastern *cities* and there are even cases where coyotes have been seen in Los Angeles. This kind of experience tells us that many forms of wildlife are tough. They are adaptable to different conditions.

Some plants and animals are fragile though, so stewardship is important. People who live in post-industrial societies will spend time and money preserving the right kinds of environments for these species. No one is happy about endangering the survival of remarkable animals like the giraffe or the koala bear, and nearly everyone favors measures to protect the American eagle. Some people feel so

MAJOR USES OF U.S. LAND 1900 and 1978 (Millions of Acres)



SOURCE: *Environmental Quality 1981*, 12th Annual Report of the Council on Environment Quality, 1981.

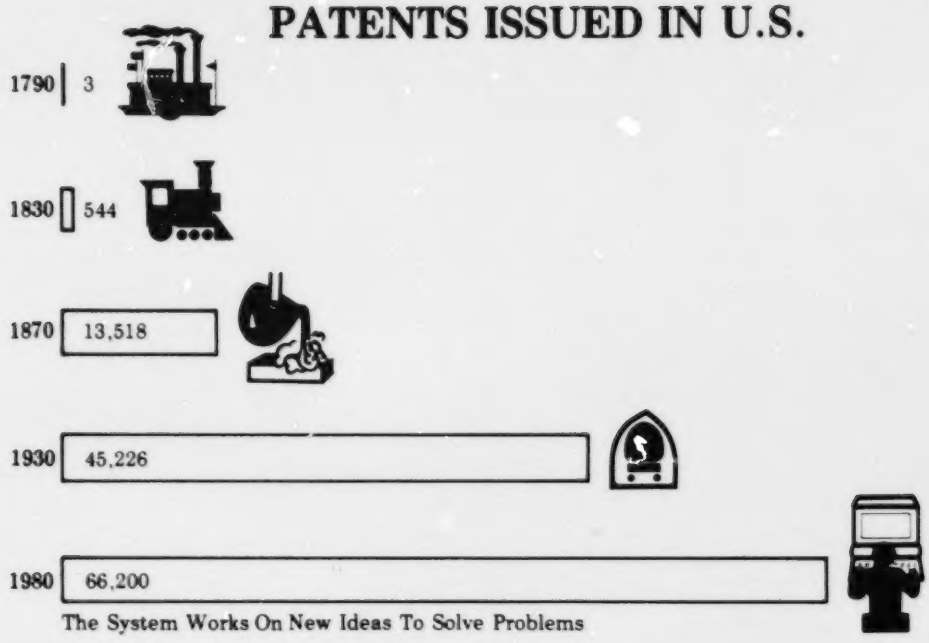
strongly about protecting plants and animals that they say that every time a species is destroyed we have permanently lost the chance to learn something that might be very useful in the future. Other people take a similar position on completely different grounds. They say we have no right to destroy *any* form of life, because that can only be a function of "God's will."

> POINT TO PONDER: Many forms of plants and animals that once lived no longer exist. We have fossil records of dinosaurs, ferns, and other things that lived a long time ago, but died out because of natural forces. Is it different when species disappear because people hunt them or change their surroundings?

A post-industrial society may adopt the attitude that people must live in harmony with nature. This is very similar to the attitudes of many pre-industrial societies. The big difference is that people in a post-industrial society can live much longer, healthier, and more comfortable lives than people in a pre-industrial society. This enormous change in lifestyle between these two types of societies is a result of learning how to make use of resources and the environment without damaging them too much. It is also the result of learning how to overcome the forces of nature.

Today, science enables us to predict the bad effects as well as the good effects of deforestation, so people are more concerned now than they were when North America was first being deforested by Indians and immigrant Europeans. This is an example of how resource and environmental problems change as societies go through the Great Transition. Some problems like famine become less important, and other problems like air pollution become more important. Some problems like deforestation keep on occurring, but people aren't concerned about them until they learn what their bad effects could be.

Industrial societies have the motivation and know the ways to solve problems. And sometimes people who are trying to solve one problem make accidental discoveries that do good in some other way. The methods we have for solving problems enable us to create resource and environmental projects without creating catastrophes. But the problem-solv-



ing process can not work properly if citizens don't understand externalities, tradeoffs, creative destruction, and how to interpret and use information.

Making Good Decisions

In order to make good decisions about the environment, you will need to examine the issues in relation to the concepts that you have been studying. When you hear or read about a project that will affect the environment, ask yourself:

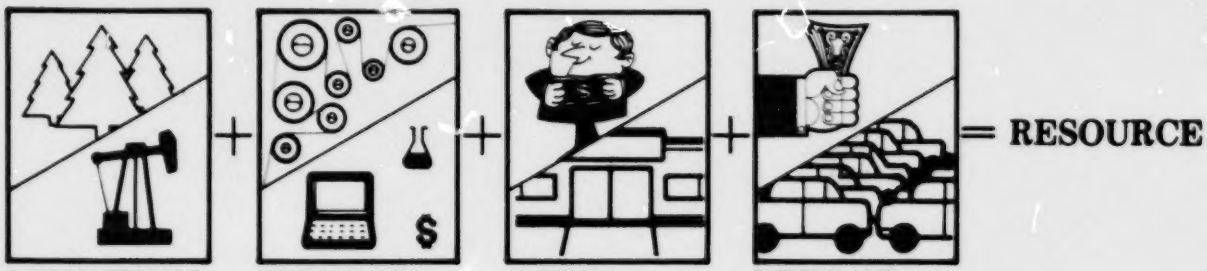
- What is the objective of the project?
- Who will bear the costs of the project?
- What will the benefits be?
- Who will enjoy the benefits?
- What are the "unknowns?"
- Are there alternative ways of achieving the same objective?

Summary

In this section you learned a new definition of the term "resources;" you read about how the use of the "resource equation" can change the way that people look at issues; and, you studied four key issues related to the debate over resources.

There are many more issues being debated than the four that are included in this booklet. The debate will continue, and people will create new issues for debate and discussion, too. As you further your education, take a job, and become a leader of the future, you may enter the debate as a direct participant. Certainly, the decisions that society makes on these issues will affect you even if you do not participate directly.

As you reflect on the resource equation and as you read the final unit in *Visions of the Future*, keep in mind that people — more than any resource issue or any resource component — are what the future is all about. Julian Simon, a noted social scientist, has said it well — people are the "ultimate resource."



RAW MATERIALS TECHNOLOGY SOCIETY SUPPLY AND DEMAND

ACTIVITIES: RESOURCES FOR THE FUTURE

ACTIVITY 11

WHAT IS A RESOURCE?

PART I

You read in your text that a resource includes not only *raw materials* but also three other components. List the three other parts below:

1. Raw Materials
2. _____
3. _____
4. _____

PART II

Now consider each of the materials listed below. Can you explain how each becomes a resource? For example, the material *uranium* is a resource because, (a) we can extract it from the ground (raw material), (b) we have a technology available that allows us to convert it into power in the form of nuclear energy (technology), (c) we have transportation systems to move it from the mine to where it is needed, colleges to teach people engineering and metallurgy, capital to invest in uranium-related research projects, and other societal skills (society), and (d) it is the best or cheapest way of accomplishing a certain purpose — nuclear power generation — so there is a demand for it (supply and demand). What about these others? (If you do not know how each is extracted, used, or transported, consult the *McGraw Hill Encyclopedia of Science and Technology, Encyclopedia Americana,* or *World Book.*)

Explain how each of the following become resources:

COPPER:

a. How is the raw material made available?

_____

_____

_____

b. What technology is used to extract, refine and use the raw material?

_____

_____

_____

c. What institutions, organizations and people skills help convert the raw material into a useful form?

d. What products or uses does the material have? (Why is there a demand for it?)

WATER:

a. How is the raw material made available?

b. What technology is used to extract, refine and use the raw material?

c. What institutions, organizations, and people skills help convert the raw material into a useful form?

d. What products or uses does the material have? (Why is there a demand for it?)

ASBESTOS:

a. How is the raw material made available?

b. What technology is used to extract, refine and use the raw material?

c. What institutions, organizations, and people skills help convert the raw material into a useful form?

d. What products or uses does the material have? (Why is there a demand for it?)

OIL:

a. How is the raw material made available?

b. What technology is used to extract, refine and use the raw material?

c. What institutions, organizations, and people skills help convert the raw material into a useful form?

d. What products or uses does the material have? (Why is there a demand for it?)

TITANIUM:

a. How is the raw material made available?

b. What technology is used to extract, refine and use the raw material?

c. What institutions, organizations, and people skills help convert the raw material into a useful form?

d. What products or uses does the material have? (Why is there a demand for it?)

COAL:

a. How is the raw material made available?

b. What technology is used to extract, refine and use the raw material?

c. What institutions, organizations, and people skills help convert the raw material into a useful form?

d. What products or uses does the material have? (Why is there a demand for it?)

ACTIVITY 12

SOLVING RESOURCE PROBLEMS

Read the scenario that follows and then answer the questions on the next page. Keep in mind that while this scenario was written about copper, it could apply to other raw materials as well.

A SCENARIO ABOUT COPPER SHORTAGES

January 1985 After American copper resources are depleted in the late 1970s or early 1980s, and the demand for copper doubles, the price of copper rises from $1 per pound in 1984 to $10 per pound in May, 1985.

May 1985 As the value of scrap copper, most of which is easily salvageable, increases from 70 cents to $9 per pound, metal dealers realize that existing United States copper supplies above the ground amount to almost 90 million tons. This, if salvaged, would be worth $1.7 trillion. A rush develops to locate old brass beds, brass handles, copper pots, lamps, locks, and all other copper scrap. Sixty-five billion pennies, now worth 5 cents apiece, are turned in to scrap dealers.

July 1985 Utility companies go into a crash program to substitute aluminum for copper in transmission lines, engineers begin designing copperless heat exchangers, many radiant-heated floors and walls are ripped open to get the copper tubing [for scrap], and plumbers are in great demand to replace copper pipes and tubing in homes and buildings.

August 1985 CBS News reports one engineer's calculation that copper could be profitably extracted from many of the above-average grades of igneous rock at a cost of about $4 per pound. At a $6-per-pound profit from the copper, the higher-grade volcanic rock in the United States is now worth about $5 a ton (net profit) and the engineer estimates that there is more than $1,000-trillion worth of this rock within 100 feet of the surface. The next morning there is a stampede at every mining claims office in the world.

September 1985 People line up with barrels full of copper artifacts at every scrap yard in the developed world, waiting for their turn to sell.

October 1985 A major retooling has been accomplished; nearly everything that used to be made out of copper has been redesigned to use other metals. Where used at all, copper is applied in only very thin films, as in electroplating.

November 1985 Quotations on copper futures [in commodity markets] plummet, and they continue to crash during the next 38 days. By the end of the year copper is once again $1 per pound, and a month later it is only 50 cents a pound. Some of the new alternatives are found to have unanticipated advantages over the original copper construction, many substitute projects are already under way, and manufacturers are loath to risk using copper again.

December 1985 The copper affair sends shock waves throughout the world's economies; some organizations go bankrupt, and many people who had bought copper futures at $8 to $10 a pound are completely ruined.

What the Scenario Signifies

A number of conclusions can be drawn from this scenario:

1. Copper is a [recoverable] resource. Mining and smelting just change it from a low-grade ore below the ground to a very high-grade ore above.
2. The aboveground reserve is scattered but easily collectible—when the price is right.
3. There will be about 90 million tons of copper in the United States—aboveground.
4. At about $4 a pound the amount of copper available from ores becomes essentially unlimited.
5. Nothing made in quantity from copper today is critical. The electrical and heat-conduction properties of copper are excellent, but substitutes are available and some may even be cheaper once the capital is invested.
6. The price of copper will be limited in the long-term future by the cost of mining it from lower-grade ores or extracting it from marine sources. Either source will be much less than $4 a pound throughout the next century.

From "Good News From Mr. Bad News," by Edward Jay Epstein, *New York*, August 9, 1976. Reprinted by permission of Mr. Epstein.

A. We fear both scarce resources and increasing resource costs. But historically many events have contributed to making resources less scarce and less expensive. List three things that can be done if a raw material does become scarce.

Example 1. Conservation

2. _____

3. _____

B. You have just listed three ways to counteract the effects of scarcity. Explain each in the space provided and then provide an example for each resource listed. (Examples for copper are already filled in.)

	COPPER	WATER	PETROLEUM
Conservation means: _____ _____ _____ _____	Make thinner wire.		
Substitution means: _____ _____ _____ _____	Use glass fibers instead of copper.		
Employing a new technology means: _____ _____ _____ _____	Use microwaves or other "wireless" communications.		

C. Now, think about the resource problems listed below. What *specific* events could occur that would be likely to solve each problem (e.g., develop a synthetic replacement for gasoline)? Write your answer in the space provided. (You might want to do some reading in reference books or consult your text.)

INCREASING COST OF GASOLINE:

DECREASING GROUND WATER RESERVES:

DECREASING AMOUNTS OF PETROLEUM STILL IN THE EARTH:

INCREASING PRICE OF ELECTRICITY:

DECREASING FARM ACREAGE:

ACTIVITY 13

RESOURCE COSTS AND SUPPLIES

The article that follows is an excellent explanation of how various factors related to oil resources affect costs and supplies. Read the article and underline each of these factors. Be prepared to discuss each factor in class.

Oil glut was predicted by researcher in '79; supply fooled others

By Betty Beard
Republic Staff

In 1979, when most oil-consumption forecasts were predicting continued rising oil prices, leading many businesses into a mad scramble for energy investments, Dr. Bruce C. Netschert was predicting the opposite.

Netschert, a vice president with the National Economic Research Associates in Washington, D.C., correctly forecast the oversupply of oil that has flooded the world for the past year.

In a recent telephone interview, he explained why so many were wrong. He said they underestimated the supply of oil and overestimated the demand.

"They apparently were either unaware or did not appreciate the geologic information," explained Netschert, who has a degree in geology and a doctorate in economics.

"Also between 1974 and 1979, there wasn't much conservation and there wasn't much of an increase in the supply of oil. Once the gas lines (caused by the 1973 Arab oil embargo) were off, people got back into their big cars. People were fooled into thinking there never would be a conservation effect.

"They confused the short run with the long run," he said. "It takes time for these things to happen, about five years."

Netschert said that oil prices rose rapidly after 1973 but that it took about five years for conservation efforts to fully take effect.

Oil prices fell and then soared again in 1979, reaching their peak in early 1980 and prompting increased drilling. But by that time, continuing conservation efforts resulted in an oversupply.

Exxon was one oil company that paid heavily for projections of continued high oil prices. The firm invested more than $900 million in a shale-oil project near Parachute Creek, Colo., expecting the expensive-to-mine source of oil to become competitive at a time of rising oil prices.

The company stopped the project in May because of the stabilized price of oil and high costs of construction and money. Exxon has no current plans to revive the project.

"It was our guess that the time was extended considerably as to when it would become viable," said DI Bolding, the firm's regional public-information officer in Los Angeles.

Another thing the firm did was to quit making its oil projections public.

Bolding said, "We didn't find them to be accurate enough to keep messing with ... Our forecasts used to be virtually accurate, but in the last two or three years (before 1980), they got so bad our directors said this is enough embarrassment. That's enough of these slip-stick-type projections.

"We're still making projections. We just quit making them public," he said.

What does the man who guessed right have to say about the future?

There probably won't be any rapid oil- and gasoline-price increases such as the nation saw in 1973 and 1979, Netschert said. He agrees with oil companies such as Exxon and Chevron and other forecasters that the country will continue to moderate its use of oil between now and the year 2000, that oil-price increases will hover around the level of inflation and that this will move back the time at which synthetic and alternate energies will become economical.

Chevron, in a recent annual forecast, predicted total energy consumption to grow at a rate of only 1.3 percent a year through the year 2000 because of continuing conservation efforts.

Netschert said the exact rate will depend on the speed with which the economy recovers.

"I tend to think it will be rather slow here and in the world as a whole," he said. "There's a lot of pervasive weakness, not the least of which is the world's shaky financial condition."

A major factor that keeps oil prices high is tight supplies, and Netschert says there's lots of oil.

"When we see the bottom of the barrel, we'll be well into the 21st century," he said, adding it will become increasingly more expensive to get but that there's plenty.

Oil drilling in the United States has declined for seven consecutive months, largely because demand has been weakened further by the recession. Netschert predicts oil drilling will pick up when the economy improves because oil is still high-priced compared with what it cost 10 years ago.

He said the United States is still vulnerable to the Organization of Petroleum Exporting Countries and will be so for the rest of the century. The best way to combat that, he said, is to stock the country's Strategic Petroleum Reserve, which now contains about 250 million barrels. The Reagan administration's goal is to stock it to 750 million barrels, which Netschert said is roughly a two-month supply of all the country's oil needs.

When the world runs short of the easy-to-get liquid petroleum, it has incredible quantities locked up in shale oil and in heavy crude in Venezuela.

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ACTIVITY 14

APPLYING TECHNOLOGY TO RESOURCE AND ENERGY ISSUES

Read this article and then answer the questions that follow it on page 112.

Petroleum companies are experimenting with esoteric new ways of forcing oil from subterranean hiding places, anticipating the day when the oil glut ends.

PUTTING THE SQUEEZE ON OIL

By PATRICK YOUNG

The oil-rich Permian Basin proved a petroleum bonanza for half a century as company after company sank wells and pumped the black gold lying deep beneath the arid lands of western Texas and southeastern New Mexico. But now that bonanza is playing out. The time is coming when all the oil that can be recovered with conventional techniques will have been pumped. So over the next few years, oil companies operating in the basin will begin injecting their fields with carbon dioxide, the common gas that puts the fizz in soft drinks and beer.

The carbon dioxide will mix with oil trapped in rock pores, thinning it to produce fluids that will flow more easily into producing wells. The vast effort will cost billions of dollars, but it is expected to extend the life of the Permian Basin 30 or 40 years and to yield billions of barrels that would otherwise never reach the surface.

"In the Permian Basin as a whole, there is going to be a significant increase in crude-oil reserves," says Lowell R. Smith of Amoco Production, Incorporated, a Standard Oil Company of Indiana subsidiary. "It is difficult to give an exact number, but it is not difficult to imagine the generation of an additional 10 billion barrels over the next few years."

Ten billion barrels at 42 gallons to the barrel is a lot of oil. Indeed, it is an amount equal to more than one-third of the United States' current proved recoverable oil reserves. So the gas that puts the pop in soda pop offers one way the nation can increase its declining oil supplies.

Carbon dioxide is just one of a number of exotic thermal, gas, and chemical techniques lumped under the general heading of enhanced oil recovery, or EOR. The oil industry has long explored the techniques in laboratory tests and pilot projects. But only recently have these complex and costly recovery methods begun coming into their own.

Currently some 375,000 — or 4.4 percent — of the 8.6 million barrels of oil produced daily in the United States come from EOR operations. But energy experts predict EOR could one day provide 20 to 30 billion barrels of oil from known fields in the United States that would otherwise be lost forever, and that EOR could add 100 to 200 billion barrels from existing fields world-wide.

Dwindling domestic reserves and the high costs of deep-ocean drilling and exploration in the Alaskan Arctic — the two places within U.S. jurisdiction most likely to harbor large undiscovered petroleum reservoirs — have heightened interest in EOR.

"Our inventory is being depleted," says John H. Guy IV, deputy executive director of the National Petroleum Council, an industry-funded advisory panel to the U.S. Department of Energy. "Either you find new discoveries in Alaska or offshore or you go back to known reservoirs and get more oil out."

The world oil glut and the resulting drop in petroleum prices have affected industry profits and delayed or slowed the opening of some EOR projects. "Drilling and exploration are way off, and EOR is just as far off," says Lloyd Elkins, an independent oil-industry consultant in Tulsa, Oklahoma.

But Guy says very few companies have cut back their EOR research. Whatever the supply and demand of the moment, oil reserves are finite. Few doubt that the oil glut will end and that demand will rise, increasing the need to squeeze ever-increasing amounts of petroleum from the ground and making EOR cost effective.

"I don't know of anybody in the industry that doesn't think EOR will come," Elkins says. "They are going to be ready and they are going to apply it."

EOR's importance lies in the fact that exploiting the world's oil deposits requires more than sinking a successful well. Contrary to common impression, oil doesn't collect in underground lakes or pools that can be pumped dry. Rather, it is trapped in the tiny holes of porous rock where natural

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underground pressures can force some of it to move. Occasionally these pressures are strong enough to push the oil to the surface to form a spectacular gusher.

These natural forces, known collectively as primary recovery methods, rely on the pressures of ground water or natural gas trapped in the petroleum reservoir to displace the oil and force it to producing wells. But these pressures alone usually allow the recovery of only a fraction of the oil in a reservoir, generally 10 to 50 percent.

Since World War II, the oil industry has increasingly bolstered production in aging fields by injecting large quantities of natural gas or water to supplement the natural reservoir pressures and keep the oil flowing. These secondary recovery efforts, however, can be extensive and costly.

Next summer, for example, the two operating companies at Prudhoe Bay on Alaska's North Slope will begin a "waterflood" project that ultimately will involve daily injection 8,000 feet underground of some 84 million gallons of water. This $2 billion secondary recovery project is expected to add 1.1 billion barrels of oil to the 8.5 billion barrels the field's owners expect to recover without it.

Secondary recovery has proved a boon. Yet experts estimate that conventional recovery — primary and secondary combined — will allow extraction of only 35 percent of all the oil underground on planet earth. Thus the growing interest in EOR methods, which could increase that figure to 45 or 50 percent.

"The strategic plan of any oil company has to include a comprehensive EOR program," says Robert A. Loosley, Conoco Incorporated's enhanced-recovery manager for North America. "We still need that oil. The oil is still there, and EOR is the only way to get it."

Briefly, then, here is a layman's look at the three basic EOR techniques — thermal, miscible, and chemical:

Thermal recovery, by far the most developed, now accounts for four out of every five barrels of EOR-produced oil, and almost all of that results from steam.

Crude oil thins as it is heated, making it flow easier. Injecting steam provides an effective way to thin oil, and over the past 20 years it has increasingly won its place in a number of fields, particularly those with thick, sluggish-flowing reserves.

Two techniques, known as steam stimulation ("huff and puff") and steam flooding, are used.

In huff and puff the steam is injected down a well for days or weeks and then turned off. The steam heats the underground rock and oil, thinning the oil and setting it flowing faster. The well pumps are then turned on to extract the oil that seeps into the well. When production drops, the oil gets another steaming, and the process is repeated.

Steam flooding, on the other hand, uses separate wells for steam injection and oil recovery. The steam is injected, heats the oil, and provides the pressure to push the thinning crude towards the producing wells. Often both techniques will be used in the same field, starting with steam stimulation and then going to steam flooding.

In situ combustion — literally the burning of some of the oil in a reservoir to provide heat — is a much newer thermal technique that is being explored. The idea, essentially, is that heat from the burning subterranean oil will vaporize lighter fractions in the crude in front of it. These will move ahead of the combustion zone toward producing wells.

The technique requires expensive compressors to inject the air needed to keep the oil burning. It is also difficult to control the burning, and when the combustion zone reaches a producing well, the well is destroyed.

"Within the industry there are mixed feelings [about in situ combustion]," Guy says. "Some feel its future is zero; others are strong backers."

Miscible means mixable. Oil and water don't mix, so they are not miscible. But there are liquids and gases that do mix well with oil when the conditions underground are right, freeing some of the crude remaining after primary and secondary recovery.

The carbon-dioxide projects planned in the Permian Basin are miscible recovery efforts. In other fields, liquefied petroleum gases such as propane, butane, and ethane can be used. Exxon Corporation has invested $109 million to inject nitrogen nearly three miles deep at the Jay field along the Florida-Alabama border to enhance production. And at its East Binger field southwest of Oklahoma City, Phillips Petroleum Company is using a mixture of nitrogen and carbon dioxide.

"It's something like flushing oil with gasoline," says A. J. Cornelius, Phillips's staff director for enhanced oil recovery. "You get a pretty good recovery from your reservoir rock."

Chemical recovery techniques use polymers, surface-active agents (surfactants), and alkaline compounds. They are the least developed — accounting for only 1 percent of the nation's EOR production — and generally the most expensive, but for some reservoirs they are the most promising of the EOR methods.

Polymers are large molecules mixed with water to thicken it so that the water flows with about the same viscosity as the oil. The result is a more uniform flow through the

"We're low technology around here."

reservoir and the displacement of oil missed by conventional secondary water flooding.

Surfactants are detergents whose actions below ground are somewhat akin to laundry products that wash grease from clothing. They are usually injected with salt water or a mixture of salt water and refined oil, and their potential for recovery stimulation is high. But surfactants are expensive, and they must be specially tailored to each field. A miscalculation can mean millions of dollars lost. And even when the formulation is right, the cost may be wrong. Phillips abandoned one planned surfactant project when it found its production costs would run $34 to $35 a barrel.

"And that wasn't allowing for any of our interest on the 8 million dollar investment," Cornelius says.

In fields where the crude is particularly acidic, sodium carbonate, sodium silicate, or sodium hydroxide may be injected. These alkaline compounds react with the petroleum acids to form surfactants underground. Conoco, for example, has built a $4-million plant to mix sodium hydroxide and water and inject it into its Grubb lease near Ventura, California. The company expects this will give it another 1.5 million barrels.

"It's washday for the Grubb lease," says John Kemp, manager of Conoco's Ventura Division.

EOR is expensive. Matching the right technique to an oil field is a complex and lengthy process that requires a detailed understanding of the reservoir's geologic and chemical properties.

"Reservoirs are kind of like people," says Amoco's Smith. "They all have different characteristics."

One and sometimes more pilot projects are necessary to test a proposed EOR technique. Moreover, the methods are costly in terms of equipment, materials, and skilled workers. They require huge investments long before they provide a payoff. And even after a successful pilot trial, an EOR effort may prove a financial failure. "There is a high risk in EOR," Elkins notes.

Yet the oil companies believe they must continue to explore, refine, and slowly apply EOR techniques. They foresee a time when squeezing U.S. reserves as dry as possible with EOR will become paramount.

"We're going to need to do it," says Arthur A. McArthur, a staff engineer with Texaco, Incorporated. "It's a fact of life: You've got to have the crude, or you're not in business."

Patrick Young helps draw down oil reserves in commuting to Washington, D.C., where he is national medicine and science writer for the Newhouse News Service.

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List the specific technologies and techniques that petroleum companies will utilize to get more oil from existing reserves and resources.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____

How does this article illustrate the components of the resource equation?

ACTIVITY 15

SOME IMPORTANT FUTURE ENERGY ISSUES

1. Should future fuel prices be left to market forces with a minimum of government interference?

2. How are fuel prices related to:
   - Long-term dependence on foreign supplies
   - National and international prosperity
   - "Squandering our limited resources"

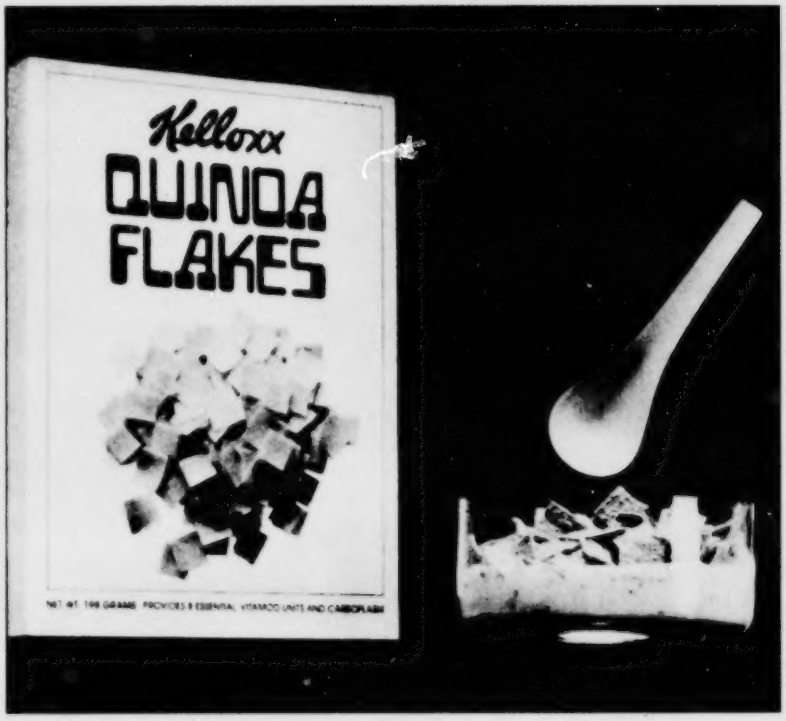
3. What are the pros and cons of some of the new energy alternatives?
   - Wind power
   - Nuclear power
   - Solar energy
   - Geothermal power
   - Coal

ACTIVITY 16

ONE SOLUTION TO THE WORLD HUNGER PROBLEM

Read the article on the next page. Then answer the questions which follow on page 116.

Technology



Photograph: Carin Krasner

Goodbye, Corn and Wheat— Hello, Quinoa and Marama Beans

By Dennis Meredith

The next time you wield knife and fork in preparation for doing justice to a hearty plate of food, consider that, in the next few decades, you might find yourself sitting down in the morning to a bowlful of crisp, nutty quinoa flakes with sliced tamarillo, or amaranth toast with custard apple jam. Or maybe you'd prefer buffalo grass biscuits with a helping of calabaza, a little malanga or a dish of boniato. A night out at your favorite watering hole might find you chomping such munchies as toasted marama beans and, if you're brave, downing a potent quinoa liqueur.

There are literally dozens of incredible edibles that could come marching across your table in the near future, thanks mainly to a relatively small band of scientists combing the world in search of better crops. From the icy reaches of the Andes to the sizzling sands of the Kalahari desert, they're retrieving samples of exotic-sounding plants like quinoa and marama beans to grow in test plots and examine for nutritional quality.

You say you're a corn-potatoes-peas-and-carrots person, and won't touch anything you can't pronounce? Actually, you're already more cosmopolitan than you think, says Dr. Noel Vietmeyer, a researcher on new food crops at the National Academy of Sciences in Washington, D.C. "Times are changing. I predict that we're going to be relying on plants more and more [as our prime food source]—and we're going to be eating more species.

"If you don't believe that times are changing, I suggest you look in your own supermarket and at your own dinner table. You're already eating Mexican fruits, Chinese vegetables, avocados, artichokes, kiwi fruits, chili peppers, salad dressings with strange herbs and alfalfa and mung bean sprouts. These are foods that your grandparents never heard of and would never think of trying."

The dedication of scientists searching out new food plants comes from more than just a desire to tickle your taste buds; they're after crops that can better withstand drought and cold, preserve farmland and offer better nutrition to starving millions in underdeveloped countries, and to well-fed nations as well.

"We're realizing the environmental limitations to our ability to use land," says Vietmeyer. "We can't keep on irrigating more deserts and draining more swamps and spraying more pesticides just so we can keep planting our pampered crops in those areas. We have to select the plant to fit the environment, instead of changing the environment to fit the plant."

So far, we've been "grossly negligent" in combing the world for new food, says Vietmeyer. Of the eighty thousand or so edible plants thought to exist on our planet, we rely for 90 percent of our food needs on just *fifteen*—rice, wheat, corn, sorghum, millet, rye, barley, cassava, sweet potato, white potato, coconut, banana, common bean, soybean and peanut.

True, these foods have served us well. Our mainstays, corn and wheat, are nutritious, give high yields per acre and store well because of their low moisture content. And, because they are annuals, farmers can plant and harvest them before pests have a chance to multiply.

Our old familiar plant friends are not without their drawbacks, how-

ever. They are originally tropical plants, having been imported from South America thousands of years ago. Thus, they need warm temperatures and plenty of rainfall. As any farmer knows, a dry year or an early frost can be disastrous to the usual crops. The worst problem, though, lies in the fact that our major food crops *are* annuals, and their harvest in the fall makes fields vulnerable to erosion by the winter rains.

"Soil erosion is absolutely the most serious ecological problem in the world," says crop expert David Pimentel of Cornell University. "In the corn-producing areas of the United States, ten to twenty tons per acre of topsoil are lost each year." At this rate, says Pimentel, only a decade is required to wash away an inch of topsoil that took two hundred years to build up."

One solution is literally under our feet, says Pimentel. Throughout our country's grasslands are species of perennial grain-producing prairie grasses that could be turned to agricultural use. The Land Institute in Kansas is experimenting with such exotic-sounding plants as buffalo grass, foxtail barley, June grass, switch grass, bullrush sedge and salt marsh cord grass, all of which hold the soil and are more resistant to drought and cold than our imported tropical corn and wheat.

"Because they wouldn't have to till the soil, farmers would save seven to eight gallons of diesel fuel per year per acre by growing perennial grasses," says Pimentel. What's more, much of the $7 billion to $10 billion in fertilizer that's washed away annually would remain in the soil to do its work, he says.

Sometimes the "new" plants that agronomists check out as better food sources aren't new at all; they've only been lost to modern agriculture through foolishness. Take quinoa (pronounced kee-no-a), called the "grain of the Inca." More nutritious than corn or wheat, this hardy protein-rich grain was a staple of the ancient Inca empire. It was so revered that each year the mighty Inca ruler would plant the first row of quinoa with a solid gold spade, signaling the beginning of all agricultural planting throughout the land.

"The reason you don't know about quinoa has nothing to do with the plant itself, but with history," says David F. Cusack, who is laboring to bring quinoa to this country. According to Cusack, quinoa's decline began centuries ago when Spanish conquerors suppressed it, denigrating it as "Indian food."

Quinoa is coming back strong in South America, and Cusack and his colleagues at the nonprofit Sierra Blanca Associates in Boulder have started test plots of quinoa in the Colorado Rockies. Their results so far indicate that the hardy, drought-resistant plant could come to occupy considerable space in farmers' grain bins—and on our tables.

Then there are food plants that weren't lost—in fact, they've never really been found, at least not by farmers. One of these, the marama (pronounced mar-ah-ma) bean, grows wild in the Kalahari Desert of southern Africa, and so far has been enjoyed primarily by members of nomadic tribes, who gather its nutlike seeds.

If anthropologist Joseph Bousquet has his way, we'll all get a chance to enjoy marama beans grown on formerly useless desert lands in our own Southwest. Working at Southwest Texas State University, Bousquet has induced several institutions to begin test plots of marama in this country to discover the ideal cultivation conditions. Also, researchers in other countries, including India, Africa, Israel, Australia, England and France, are beginning to study this new plant as a drought-resistant food source.

The biggest question, though, is whether we'll be willing to eat such new plants. After all, we've discriminated against perfectly good foods in the past because of pure personal prejudice. Of one food, an English author wrote in 1708 in the "Gardener's Kalendar" that "the root is very near to the Jerusalem artichoke, although not so good and wholesome, but it may prove good to swine." He referred to the potato.

And in 1820, one Robert Gibbon Johnson offered to stand on the steps of the courthouse in Salem, New Jersey, and publicly eat another food that everybody *knew* was poisonous. A large crowd turned up, expecting him to die from eating a tomato.

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1. Why are famine and malnutrition much less common today than at the beginning of the Great Transition?

2. How can technology help solve hunger problems?

3. What is the relationship between a developing country's exports (and its economic growth in general) and the hunger problems that some of its people may experience?

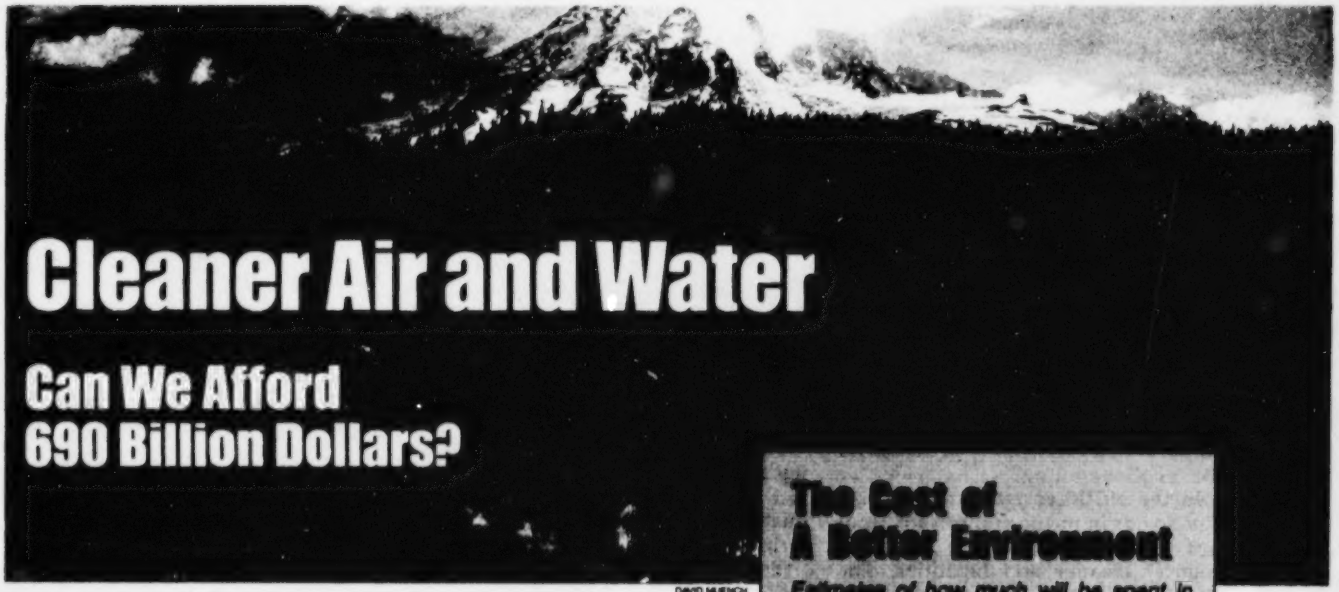
4. What "new" foods look promising for supplying foods in the future? (You'll need to do library research to answer this question.)

ACTIVITY 17

ENVIRONMENTAL TRADEOFFS AND EXTERNALITIES

Read the two articles that follow. How does each illustrate the concepts *tradeoffs* and *externalities?* In each case, the people affected need to make choices. What choices would you make? Why?

Reprinted from U.S. News & World Report



Cleaner Air and Water

Can We Afford 690 Billion Dollars?

DAVID MUENCH

The environment is in its best shape in years. Now comes the toughest part—the final costly steps to protect people and nature from the backwash of progress.

The uproar over the goals and methods of the Environmental Protection Agency throws a spotlight on a national crusade against pollution that has reached a crucial turning point.

Nearly 15 years after Earth Day ushered in the era of environmentalism, progress in cleaning up the United States is undeniable. Air in 20 major cities is measurably cleaner than it was before passage of the Clean Air Act in 1970. Fish are swimming in lakes and streams that a few years ago were devoid of life. Government and industry are spending 50 billion dollars a year—$220 for every man, woman and child in the U.S.—to reduce pollution.

Yet the nation still faces serious obstacles to making the environment even cleaner, and some people are skeptical that the goal is worth the tremendous cost in money, time and lost jobs. The EPA reports that 111 of the nation's 3,000 counties, most of them in major metropolitan areas and with a total of more than 50 million people, failed to meet a January 1 deadline for complying with federal air-pollution standards. Attaining fishable, swimmable waters by July 1—goal of the 1972 Clean Water Act—seems equally unlikely in many places.

Frightening incidents at Niagara Falls, N.Y.—and more recently at Times Beach, Mo.—have focused attention on a new generation of environmental hazards that defy easy solution: Dangerous wastes.

Some 800 families had to leave Niagara's Love Canal area in 1979 after health experts linked unusually high rates of illness and death there to chemicals leaking from an old industrial dump.

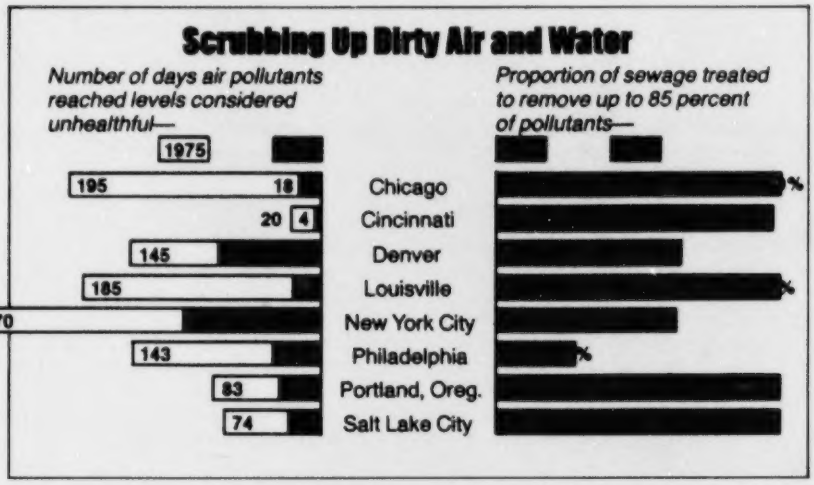
In recent months, another alarm was sounded in the St. Louis suburb of Times

The Cost of A Better Environment

Estimates of how much will be spent in 1980-89 to combat pollution, stated in constant 1982 dollars to discount the effects of inflation—

Air pollution	$393 bil.
Water pollution	$228 bil.
Solid-waste pollution	$ 22 bil.
Land reclamation	$ 19 bil.
Noise	$ 11 bil.
Toxic substances	$ 11 bil.
Drinking water	$ 4 bil.
Pesticides	$ 2 bil.
TOTAL COST, 1980-89	$690 bil.

Outlays in the 1980s—more than two thirds to be spent by industry—will exceed those of the '70s by 53 percent.



Beach over waste oil laced with dioxin —one of the most toxic man-made substances and a suspected cause of cancer—that in the early 1970s was sprayed on Missouri roads to keep down dust.

Like a buried time bomb, the poison lay just below roadways for 12 years before this winter's floods flushed it through the small town. Estimated cost of relocating residents and removing the contamination: 47 million dollars.

The cost of cleaning up Times Beach is only a fraction of what will be spent in coming years on problems that were not foreseen when environmental laws were being written in the last decade.

Use of a 1.6-billion-dollar, industry-financed Superfund for cleaning up hazardous-waste dumps lies at the heart of the current EPA blowup.

Experts warn that it will be enormously difficult and costly to cope with acid rain and depletion of ozone in the atmosphere, protect workers from occupational health hazards, remove deadly chemicals from water supplies, clean up long-abandoned toxic-chemical dumps and store radioactive waste.

Comments Lester Brown of the Worldwatch Institute: "We've made encouraging progress, but we're not home free yet. We know about pollution from smokestacks, and so we've controlled that pretty well. But we're just learning about the effects of synthetic chemicals. We may be chasing them down for as long as you and I may live—or at least for the indefinite future."

In the 1970s, an estimated 450 billion dollars in public and private funds was spent in the drive to make the country cleaner and healthier. The Economic Unit of *U.S.News & World Report* estimates that government and business will need to spend 690 billion more during the 1980s. Much of the cost may be borne by some of the most depressed industries: Steel, auto, rubber and other heavy manufacturers.

Is a cleaner America worth the price?

Says Lester Lave, a Carnegie-Mellon University economics professor: "It costs as much to go from 95 to 97.5 percent control of pollution as it did to get to the 95 percent removal stage. In order to go that extra increment, you have to install new technology."

Checking opinions. Business doubts about cost vs. benefits of a cleaner environment apparently are not shared by the public. A survey by pollster Louis Harris in December found that 65 percent of those interviewed want industry to install the best water-pollution-control equipment available—even at the expense of jobs.

In a comprehensive public-opinion survey of environmental and economic issues that was sponsored by the Continental Group, Inc., a Stamford, Conn., firm, 77 percent of the respondents put a high priority on a clean environment, even though 70 percent believed they have been hurt by the recession.

Public support for the environment also is reflected in the growing political power of groups such as the Wilderness Society and the Sierra Club. In last November's election, 34 of the 48 congressional candidates backed by environmentalists won. Responding to public opinion, Congress has rejected nearly all attempts by the Reagan administration to relax environmental laws and regulations.

Yet translating public support for antipollution programs into results is likely to prove difficult, as the following reports suggest. □

By RONALD A. TAYLOR

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Tacoma Gets Choice: Cancer Risk or Lost Jobs

By PHILIP SHABECOFF
Special to The New York Times

WASHINGTON, July 12 — The Environmental Protection Agency today asked the citizens of Tacoma, Wash., to take part in a difficult decision: Should they accept some risk of cancer from arsenic in the air rather than face the probable closing of a copper smelter that provides 800 jobs?

The agency proposed a new standard to limit emissions of arsenic into the air but also conceded that the new rules would entail risks to health. Although the proposed standard would apply nationwide, it would chiefly affect Tacoma because the copper smelter there is the only one in the country that uses ore with high arsenic content.

In what William D. Ruckelshaus, the Administrator of the environmental agency, described as a new policy of involving the public in the agency's task of managing the risks of pollution, an intensive campaign has begun to inform the citizens of Tacoma about the proposed health standard, its risks and about the alternative: closing the plant if the risk is to be eliminated entirely.

At the end of the campaign, the citizens will be asked to give their opinions at a series of public hearings. In an interview, Mr. Ruckelshaus said that, while the final decision on the proposed standard would be his, he would give the views of the citizens heavy weight.

He also said he would welcome any proposal that would offer a solution other than a relatively high cancer risk or closing the smelter, which is operated by Asarco Inc. As an air pollutant, arsenic, a deadly poison, has been found to cause lung cancer and other illness.

"For me to sit here in Washington and tell the people of Tacoma what is an acceptable risk would be at best arro-

Continued on Page A12, Column 4

Tacoma Weighs Risk and Jobs

Continued From Page A1

gant and at worst inexcusable," Mr. Ruckelshaus declared.

He said he was not taking a referendum but would see if a consensus emerged from the public meetings and mail after the people of Tacoma were informed of the choices. "I don't know what we'll do if there is a 50-50 split," he added.

The new arsenic standard, which was required as of Monday under a Federal court order issued last January, requires the use of "best available technology" to reduce emissions of arsenic at the Asarco smelter, as well as at other copper smelters and some glass plants around the country.

The standard would require the Tacoma smelter to lower its arsenic emissions to 172 million grams a year, from 282 million grams.

The agency reported that the risk of contracting lung cancer for people most exposed to the levels of arsenic now being emitted from the smelter were about 9 in 100 over a lifetime. The estimated number of lung cancers in Tacoma produced by arsenic emissions from the plant are about four a year, the agency said. From 71 to 94 people die each year of lung cancer from all causes in Tacoma, the agency said.

The new standard would lower the chances of contracting lung cancer by the most exposed population to 2 in 100, according to the agency. The estimated increase in lung cancer in the Tacoma area from the emissions would be reduced to one a year.

Mr. Ruckelshaus noted that by public health standards, these are still high-risk levels. He also noted that the Clean Air Act of 1970 calls for the establishment of standards that afford the public an "ample margin of safety" from toxic air pollution. But he said that in the case of a cancer-causing agent such as arsenic, there was no known threshold of safety.

Risk could not be eliminated entirely, therefore, without eliminating the emissions, he said. In this case, according to E.P.A. calculations, the risks could not be reduced further without undermining the economic viability of the smelter, which is said to pump about $20 million a year into the local economy.

In a statement, Asarco said it would spend $4.4 million to meet the new arsenic standard.

The statement disputed the environmental agency's contention that emissions from the plant increased the incidence of lung cancer in the Tacoma area, saying that monitoring data had shown no increase in cancer in the area.

David D. Doniger, a senior attorney for the Natural Resources Defense Council, a nonprofit environmental group, said the health risks under the new standard remained "very, very high."

He said, "No one wants to close a plant, but these risks are really too high to tolerate," Mr. Doniger said, adding that he was not convinced that the plant had to be closed to lower the risk.

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PROBLEM SOLVING IN A TIME OF CHANGE

One thing about which historians agree is that modern society is characterized by change. In pre-industrial society things changed very slowly (evolutionary change). During industrialization, change is rapid (revolutionary), as can be seen in poor countries that are now industrializing. Changes also continue to happen very rapidly during the super-industrial stage of the Great Transition.

Some of the most exciting, but also most troubling, aspects of super-industrial societies are the rapid changes that take place. Many problems that concern us as individuals and as members of society are partially the result of large projects that have resulted in dramatic changes. These changes affect the way we live, the way we look at the world, and the way we look at ourselves. New technologies are often responsible for creating these rapid changes.

SOCIAL LIMITS TO GROWTH

In pre-industrial societies it often took centuries to establish a new idea or a new way of doing things. Some people who developed new ideas or technologies were actually killed for doing so! Some people who resisted new ideas were afraid that change would be dangerous to their society. The values and attitudes of people play a major role in determining how a country will grow and how fast that growth will be.

Western societies (the U.S. and most European countries) have long valued progress. Other societies value traditions and the past more than they value progress. Attitudes towards progress indicate willingness to change. When something changes, the old can be lost when the new is created.

You will recall that *creative destruction* is used to describe the process of destroying something old for the sake of creating something new. This may sound like a negative process; however, it also is positive. For example, rural areas such as farmlands and forests may be destroyed to make room for houses and schools. People are usually unhappy about destroying things (especially things of nature), but in order to progress we always make some sort of change. Societies do not begin to industrialize until people believe that the benefits of change are greater than the losses. In some societies the limits on change or economic growth are not physical, they are social.

SOCIAL LIMITS TO GROWTH: An Example

The most important inventions in the Industrial Revolution have faced strong public opposition. Why? Because inventions like the train and the car changed people's lives. Social limits to growth can happen when people object to some change.

Men such as Sir Goldsworthy Gurney and Sir Charles Dance, for example, encountered strong public opposition to their steam-powered motor carriages. People were simply frightened by vehicles weighing 3,000 pounds travelling at "dangerous" speeds of 17 miles per hour. The public's opposition limited the growth of these early vehicles in two ways. First, the owners of horse-drawn carriages (which controlled the passenger market) had laws passed which forced steam-powered vehicles to pay as much as ten times more to use toll gates and bridges. Second, the frightened citizens persuaded Parliament to pass the Locomotive Act of 1865, which said that carriages could not go over 2 miles per hour on public roads (4 mph in rural areas!). This law was called the Red Flag Act, because it required that each steam-powered vehicle have a man 60 yards ahead of it carrying a red warning flag. Since the law was not changed for 30 years, it severely limited the growth of road transportation in England.

POINT TO PONDER: If someone were going to destroy your house to create an important, new freeway, what would your attitude be? If someone were to destroy an acre of farmland to create houses, what would your attitude be?

You have seen that the middle-income, industrializing countries are on the rapid part of the economic growth curve. Why has growth slowed in the rich countries? To understand this you will need to recall the term Gross National Product (the estimated value of all goods and services produced by a country). The GNP of rich countries grows slowly partly because their populations grow slowly, but this is not the whole story. This slowing of economic growth of rich countries cannot be explained in terms of physical limits to growth, such as lack of natural resources, energy sources, and land. Rich countries generally have access to raw materials. Instead, it results to a large extent from *social limits to growth.* As people and countries reach high levels of affluence, some people shift from pro-economic growth attitudes to anti-economic growth attitudes, or to indifference. Changes in attitudes toward growth can create a *countervailing force.* When people are rich they often value additional wealth less than they value things like wilderness for hiking or old buildings that remind them of their history. Some people in a rich society might say:

> "We have had enough 'creative destruction.' We are rich enough already. We are no longer willing to pay the costs of rapid economic growth. We want more protection of the natural environment and of historical buildings. We want most kinds of new construction to go somewhere else, if they have to be built at all. We are less willing to believe that new technologies will do more good than harm. We want more leisure time to engage in the hobbies that our affluence lets us afford. We want jobs to be interesting. We want fewer cars cluttering the roads and fewer housing developments ruining the beauty of the landscape."

Social limits to growth will occur in societies that have these attitudes.

At the end of the Great Transition it is probable that most societies will have gone through a time of rapid industrialization and then have slowed down because of social limits to growth. But many countries that are industrializing now have not yet reached a point where social limits will slow them down.

Change affects society and its people in many ways. Some people react very negatively to change and other people accept it; still others vigorously promote change. As you read the sections that follow remember that you live in a time where rapid change is occurring. How you view the changes that occur will make a big difference to your society.

PROBLEM SOLVING IN A TIME OF CHANGE

President Andrew Jackson received an interesting letter in 1828. . . .

> *Dear Mr President,*
> *The canal system of this country is being threatened by the spread of a new form of transportation known as railroads. The federal government must preserve the canals.*
> *As you well know, Mr. President, railroad carriages are pulled at the enormous speed of 15 miles per hour. The Almighty certainly never intended that people should move at such breakneck speed.*
> *Signed*
> *Martin Van Buren*

The writer also lists the dire consequences to follow if the canals are not preserved: massive unemployment, a mortal threat to essential industries, and increased vulnerability to British attack. This letter is interesting in itself, but also because its author, Governor Martin Van Buren of New York, became the 8th President of the United States several years later!

Why did Governor Van Buren write this letter? One answer is that New York City had just recently

become the biggest city in the United States. New Yorkers felt very dependent on the goods that came to and went from their city through the Erie Canal and did not want that to change. But Martin Van Buren was probably also serious in worrying about the effects of traveling at the "breakneck speed" of 15 miles an hour. People were concerned about the effects of railroad speeds on health, not just the accident hazard. You may have read about similar concerns before the first astronauts left the Earth's atmosphere. Despite all our scientific knowledge, no one was positive that the human body could function normally under zero-gravity conditions. Practical experience and the gathering of relevant data was necessary to show that this was not a serious problem.

Despite Martin Van Buren's letter, railroads were promoted by the government. Americans accepted railroads very quickly, despite the pollution, accidents, and fires they caused. Trains did reduce jobs and trade on the canals, but they also created jobs and trade elsewhere. Trains were also one of the most important technologies promoting the Industrial Revolution. They permitted the growth of big cities. They opened the American West. The railroad system, like many other developments, solved problems, caused problems, and created change.

UNDERSTANDING GLOBAL PROBLEMS

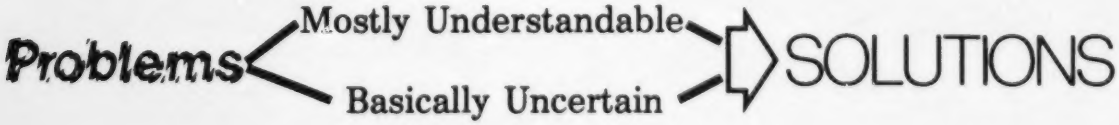
When your grandchildren ask you about the problems that you faced in the 1980s, they may react to your "problems" the same way you reacted to Martin Van Buren's "problems!" That is, they may seem rather absurd since they really did not turn out to be problems. However, some of our present-day concerns are like those that Van Buren expressed because he lacked sufficient information to fully understand the problems. Other problems we face are much larger in scope. Determining whether a problem is *really* a problem all depends on perspective.

One way to look at the world's problems as it goes through the Great Transition is to divide them into two groups. One group can be called *mostly understandable problems*. The second group can be called *basically uncertain problems*. You have already studied some of the "mostly understandable" problems: population, world economic development, resources, energy, food, and the environment. Even though the world is very complicated, we know how to define these problems, how to get data on them, how to interpret the trends these data show, what to expect in the next generation or so, and what actions we could take to solve these problems.

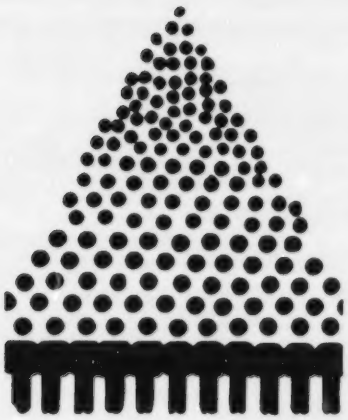
When these problems are misunderstood, it is usually because people have bad information or don't understand basic concepts. It is not because experts are puzzled. Most experts agree that these "mostly understandable" problems *can* be solved, although they may differ on what they feel is the "best" way to solve them.

On the other hand, experts differ widely on the probability that the "basically uncertain" problems will be solved. They differ on the probability of major, unexpected calamities. They are not sure what data is needed to find solutions. They differ on how much of the solution to these problems requires efforts that people will not be able or motivated to make. They often are not even sure if there really is a problem posed by the circumstances. "Basically uncertain" problems are far more difficult to solve than "mostly understandable" problems.

The following pages describe some major problems that are mostly understandable and solvable, and other problems that could become very dangerous because we don't currently understand enough about them.



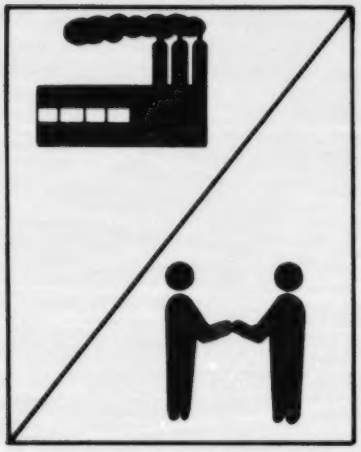
MOSTLY UNDERSTANDABLE PROBLEMS (THAT ARE SOLVABLE)



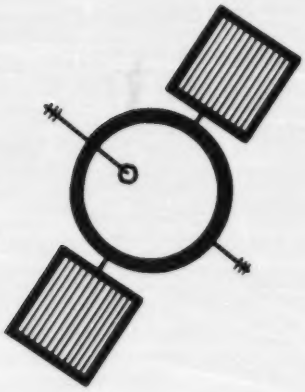
1. *Population growth.* The growth rate of the world's population has slowed down. It seems to have reached a peak in the 1960s. This rate is on the decline now. And, as more countries go through the Great Transition and industrialize, their population growth rates will slow even further. Although the world's population is still increasing and will continue to increase during your lifetime, so is our ability to feed and care for people. Certain countries or smaller regions may experience population problems, but there is no need to worry about a growth rate that creates a population greater than the earth can sustain.

2. *Running out of raw materials (and other resource issues).* There are enough raw materials currently available to meet the needs of a world population much greater than the current world population. This is so even without using exotic new technologies. Nevertheless, new or more efficient technologies *will* be at our disposal in the future. Short-term and local supply problems could occur because of geopolitical problems, but almost inexhaustible — or substitutable — resources are available for all but a very small percent of materials. However, there could be setbacks in food production during years when crops are poor, and we will experience some changes as new forms of energy are developed.

3. *Acceptable health levels for the environment.* Clean water, clean air, and natural landscapes will not be free, but are attainable and feasible in an affluent, technological society such as ours. Different societies will make different choices on these issues. There will continue to be tradeoffs and externalities. Fortunately, most of the bad environmental results of these choices can be improved if the society is willing to pay enough.

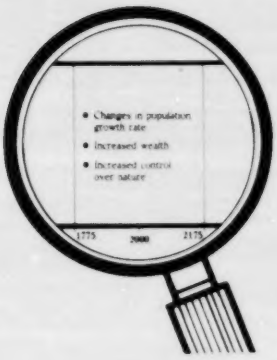


4. *The shift in the economic base of society.* The move from industrial to service occupations is occurring in the advanced nations. Temporary job dislocations and difficulties for employees who cannot be retrained will remain a small but persistent part of the economy. The shift of women and minorities into the workforce will continue. It will still be hard to fill some unpopular jobs, too.



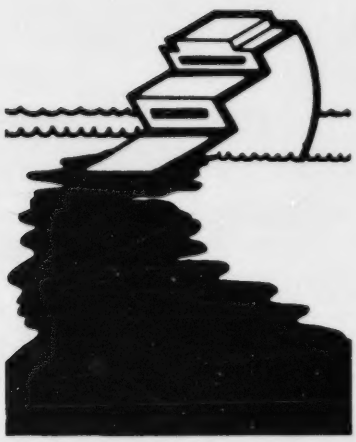
5. *The effects of advanced technology.* Investment in and development of advanced technologies will continue. These technologies will assure our progress. They may also create social problems — such as displacing workers, isolating people (e.g., work at home) and could "dehumanize" society under certain conditions. However, people control technology, not vice-versa. Society has the ability to adapt to the ways in which technology affects lifestyle.

BASICALLY UNCERTAIN PROBLEMS (THAT COULD BE DISASTROUS)



1. *The completion of the Great Transition.* Many societies have had periods of great expansion and wealth, but often internal problems or external forces later caused their collapse. As we have seen, the Great Transition should end with a world-wide civilization based on industrialization. But no society has finished this transition yet. Since this is a new type of cultural change, its prospects are uncertain.

2. *Social problems from changing values and attitudes.* People in affluent societies could fail to understand what their society needs, as their values change. This can make it difficult for the society to operate well. Lack of common goals and attitudes can cause tremendous difficulties within a society.



3. *Possible ecological or environmental castastrophes.* Both the scale of super-industrial projects and the rapidity with which new things are introduced may result in our crossing some threshhold where catastrophe is unavoidable. (See example on next page.)

ONE POSSIBLE ENVIRONMENTAL CATASTROPHE

You may have heard something about depletion of ozone in the upper atmosphere. Ozone is a chemical that is generated when sunlight hits oxygen in the stratosphere. A chemical reaction takes place, and ozone is the result. The amount of ozone in the upper atmosphere is rather small. However, it shields us from the ultraviolet rays of the sun. These are the rays that cause sunburn and also skin cancer. If ozone is depleted, the atmosphere is less able to shield us from these rays. Other life forms would be affected as well.

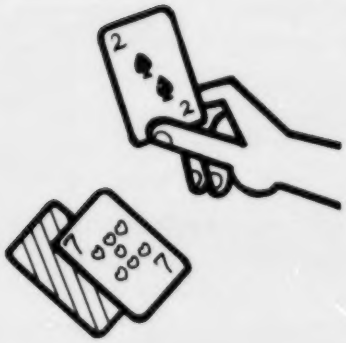
Ozone depletion is a negative externality that results from modern technology. Scientists found that the freon gas used in aerosol spray cans could reduce the ozone layer. It was also believed that the supersonic transport (SST) could do this. No one actually knew how much freon or how much exhaust from an SST was necessary to reduce the ozone layer. No one knew how much thinning of the ozone layer was necessary to cause measurable problems on earth. No one knew how long the ozone layer would take to replenish itself if it was partially destroyed.

Also, other chemical products of industrial societies may be affecting the ozone layer now or may do so in the future. As you can see, part of this problem is that we can't even accurately define the problem. It is complicated by the fact that the ozone layer was only discovered recently. For all we know, it may do a great deal of growing and shrinking for reasons that have nothing to do with human activity. We can now measure trends in the ozone layer, but we don't have enough knowledge to interpret changes. It is possible that there is nothing to worry about. It is possible that there is a great deal to worry about.

We often have to make decisions on the basis of very incomplete information. Nonetheless, we are probably doing the right things. This includes research on the ozone layer, on what affects it, and on the kinds of harm its depletion would cause. It includes the United States and other major users of freon in aerosol cans passing laws to phase out this use. Now we use substitutes. If freon-propellant sprays are the main problem, we will not have to make further important decisions on this matter.

Ozone depletion is an example of problems that arise because of the scale and character of activities in the super-industrial era. But think about it. We are not sure there is a problem. If there is a problem, we are not sure what caused it. If we eliminate what we think is a cause of what we think is a problem, we don't know what else, if anything, we need to do!

4. *Control of weapons and terrorism.* Our ability to limit large scale destruction by either conventional or nuclear war is uncertain; so is our ability to control terrorist action. Internal and external political and economic issues, and strained relations among nations, will continue during the period of rapid change caused by industrialization and new technologies.



5. *Bad luck and bad management.* Most of the "understandable" problems that we face can be solved with relatively *low* quality management and only average luck. But solving "uncertain" problems is much more difficult and requires good decision making (high quality management). Some problems, such as a series of shocking and unexpected events, could prevent the Great Transition from being successfully completed, but if people make very bad decisions (bad management) it is almost certain that the Great Transition will not fulfill its bright promise. This good management that is so important depends upon both our individual and collective decisions.

YOUR CONTRIBUTION

Once you understand the causes and potential solutions of a problem, it is usually easy to decide what kinds of skills, jobs, monies and actions are necessary to implement the solutions. Every job and every person can, in some way, help society to solve problems and successfully finish the Great Transition.

Your choice of a career can contribute to the solution of some of the problems that we face now and that we may face in the future. Thus, choosing a useful career is one example of the kind of good management that will be required to ensure a bright future.

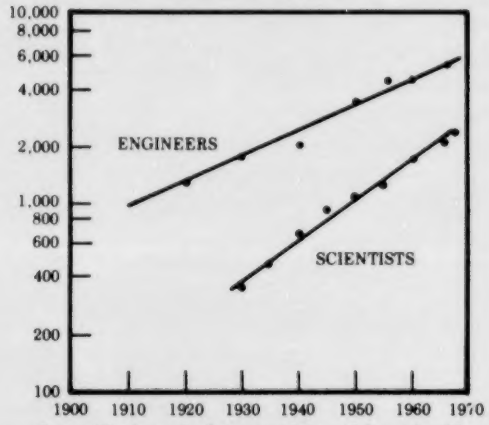
PROBLEM:	JOBS THAT CAN HELP SOLVE IT:
• Energy sources for the future	Hydrologist who studies tidal power; retail sales of shading devices for windows; coal mining machine operator.
• Hunger in poor countries	Agricultural technican who develops a way for poor farmers to grow larger crops; a United Nations business analyst who helps set up profitable local industries; bookkeeper who records grain sales.
• Ozone depletion	Biochemist who studies ozone; lawyer who works to ban certain products; reporter who explains the problem to the public.
• Water pollution	Machinist who figures out a better filtering device for an industry; health department technician who tests water samples; clerk who compiles and types water pollution reports.
• Terrorism — plane hijackings	Airport security guard; political scientist who develops an international agreement; electrician who develops a better airport screening device to detect weapons.

Barring bad luck and bad management, countries that industrialize will be able to support a higher standard of living for their citizens. The United States started this process early and had favorable conditions and abundant resources. As a result, the United States is now among the wealthiest countries in the world.

This wealth has led to the creation of problems and to the implementation of solutions to these problems. It has also led to many changes in attitudes toward work and changes in what Americans want and need. As a result of our wealth, we have more leisure time. Because we have made our farms and industries so productive, we now can have many of the goods we need, and still have money and time for luxuries.

Knowledge gained by the U.S. and other countries during the Great Transition means we can go

NUMBER OF SCIENTISTS & ENGINEERS PER MILLION CITIZENS



Logarithmic scale for growth trend for scientific and engineering personnel in the U.S.

Source: T. Gordon and A. Shef, "National Programs and the Progress of Technological Societies" presented to American Astronautical Society (March 1968).

places and use resources that once were beyond our reach. The United States has been the world's leader in the growth of the scientific knowledge and technology that enables us to do these things. However, the growth of technology is also largely responsible for a change in the job market.

In the future, there will be a decrease in industrial jobs and an increase in service jobs. In addition, new scientific knowledge and technology is opening up whole new fields of learning and work. People who understand the conditions in outer space and on ocean floors will become increasingly valuable. Biology, medicine, electronics, and chemical engineering are just some of the fields where new jobs for technicians and scientists are being created.

Machines and automation will play a major role in determining future job opportunities. Changes in technology may mean relatively fewer people working in mines, forests, steel mills, automobile plants, and other primary and secondary activities. But in response to these changes there will be a great demand for women and men who know how to use the new technologies. Service oriented (tertiary) jobs will continue to grow, too.

Every job and every person can contribute to the solution of the world's problems. In the next section you will learn some specific jobs that will be in demand in the future. As you read about them ask yourself — does this job sound interesting? What kind of training is necessary to get this type of job? How can this job help solve problems?

CAREERS OF THE FUTURE

As much of the world is overtaken by the electronics revolution and a host of expanding new technologies, many jobs of today may soon become jobs of the past. In their places whole new fields of work will probably open up. Many of these will be based on the design, service and supervision of technological labor-savers.

Already, big U.S. automakers are replacing some of their human workers with robots. Robots will perform some tasks that are dangerous for people to do. Although these machines will clearly surpass their human counterparts in some skills, human supervisors will still be needed to ensure that the robots consistently perform their jobs to specifications. And when the robots fail, *robot technicians* will be needed to service, repair and update worn out robot parts. Experts predict that more than one million robot technicians should be on the job by 1990 at a salary range of $15,000 to $20,000.* *Robotic engineers* needed to design these machines will start at salaries approaching $40,000.

Laser technology (high intensity, controlled light beams) should open the job doors for many people. Lasers will be used to perform difficult and exacting surgery and will also be used for telecommunications, among other things. *Laser engineers* will be needed to design specialized laser equipment for medicine, scientific research, tool and die shops, communications, recording and other industries, many yet to be invented. A related field, holography (three dimensional light imagery) will require *holographic engineers* to design components for robot guidance systems.

To keep all this new equipment in good order, companies will demand *laser* and *holographic technicians* with skills in maintenance and operation of the laser devices. Somewhere between 200,000 and a million laser and holographic technicians will be needed by 1990, at salaries comparable to robot technicians.

Genetic engineering also has a bright employment future. *Genetic engineers* and *genetic engineering technicians* may work on such tasks as the development of new crop strains that can "feed" on air; the production of cheap, effective vaccines against cancer, heart disease, and mental illness; the ongoing development of bacteria that "eat" oil spills; or the conversion of waste materials into useful fuels. At least 250,000 persons will soon be employed in genetic engineering and related industries. Technicians should start work for approximately $30,000 per year.

Another health care field, bionic medicine, will employ workers to develop, build and service replacement parts for the human body. As our population increases and people live longer, the demand for "spare" parts will skyrocket. *Bionic technicians* should number 200,000 by 1990 at a pay schedule of $30,000 or more per year.

Many forecasters predict that cars, trains and even our homes will someday be powered by electricity stored in sophisticated new batteries. Therefore, workers will be needed to design, install and service these future high energy fuel cells. Expect about a quarter of a million *battery technicians* in the labor force by 1990, earning a starting salary of between $15,000 to $25,000 per year.

What about existing jobs that promise a secure future? Leading the list of "growth occupations" are those jobs involving information processing, computers and telecommunications.

Computer mechanics and *service personnel* are already in short supply, particularly considering the growth of new video games, personal computers, and word processors. Similarly, *computer programmers* and *systems analysts* are secure since their services will provide compatible components and software for business computer users. Programmers also supply us with the ever increasing array of new video game designs and educational materials. Many jobs will also be available for people who are skilled in engineering fields related to *telecommunications*. Vast new cable television networks will spring up; satellite receiving stations will become commonplace, and people will communicate using many new technologies. In ad-

*These salaries and following salaries are approximate, expressed in 1980, not 1990 dollars. Salary figures and number of jobs that will be predicted available are derived from Dept. of Commerce and U.S. Dept. of Labor data and business/industry sources.

dition, "paperless" offices and "electronic mail" will create a demand for *secretaries* trained in these areas and people who know how to get machines to "talk" to other machines.

Social workers will find a new area of need in the growing population of elderly people. Those social workers who specialize in this new field will be called *geriatric social workers*. Some 700,000 of them will be needed by 1990 at an average salary of $15,000 to $25,000.

Many workers will be needed to handle the expanding store of hazardous wastes that will be generated by high tech manufacturers and nuclear power plants. Although robots will face the "dirty work" involving direct contact with the waste materials, hazardous waste managers and technicians will have to monitor disposal sites, collection and transportation systems, and emergency clean up operations. Possibly 300,000 to one million new jobs will open up in hazardous waste management by 1990, at starting salaries ranging from $25,000 to $30,000.

Energy industries will create more jobs as our energy needs change. Some workers will seek and exploit low cost energy sources such as new oil and coal reserves, synfuels, solar conversions, and shale oil extractions. Other *energy technicians* and *engineers* will discover new ways to conserve the energy we already have by improving energy transmission and insulation, and developing materials and processes that are simpler, lighter and more energy efficient. Expect 650,000 new jobs in energy technology by 1990 at salaries of at least $20,000 per year.

Diagnostic computers and advanced remote monitoring devices will help doctors spread their skills farther, faster and more accurately in the future. Consequently, the demand for doctors may reduce somewhat, while the roles of *paramedics, nurses,* and *medical technicians* will increase sharply. Other health experts will be needed, including *nutritionists, physical therapists* and *speech pathologists*. Once again, these workers will primarily be technicians and nurses — not doctors. Health care jobs should increase at least one million by 1990 with salaries ranging from $15,000 to $30,000.

Many other traditional jobs appear to be secure in the future. For example, housing will continue to be in demand as our population grows. The ranks of *builders* and *building rehabilitation specialists* — those who renovate or redesign existing buildings — should grow as well. Forecasters anticipate 500,000 new housing rehabilitation specialists by 1990.

Legal needs will also continue. But forecasters predict new *paralegals,* not lawyers, will handle a greater share of the legal case load. Paralegal employment should more than double by 1990.

Food service industries will continue to expand. *Fast food workers* will be needed to help working families keep to busy schedules and budgets. Expect about a 70 percent growth in fast food employment.

On the other hand, the trend toward increased leisure time should keep traditional restaurants and their *chefs* busy. Also, an expected increase in food processing companies may up the demand for chefs in those industries, too.

Child care needs should rise as the population grows and more parents seek work. Old fashioned *baby sitters* and trained *preschool teachers* should both benefit — to the tune of about a 65 percent increase in employment.

Nobody expects our tax responsibilities to diminish either. *Tax preparers* should realize a steady growth as more potential taxpayers enter the world each year. The numbers of tax preparers should swell approximately 75 percent by 1990.

Veterinarians will also keep busy since more people will own more pets. Experts predict about two-thirds more veterinarians in 1990 than today.

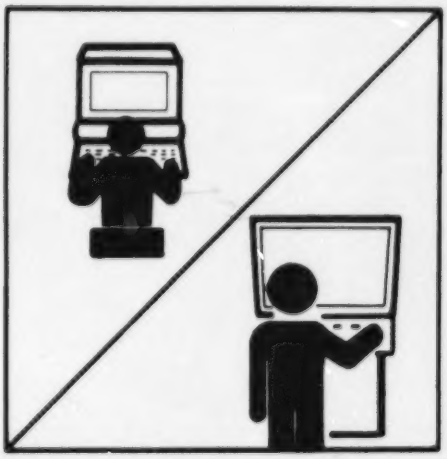
Of course, while new industries are created, many old jobs will be lost. Deep rock miners and assembly line workers may be totally replaced by "smart" robots. Linotype operators and other printing related jobs may soon become obsolete with the development of computerized word processing. Switchboard operators will almost disappear as they become replaced by computerized communications systems. And air traffic controllers could be ousted by flying AWACS (Aerial Warning and Control System) centers, or even satellites, that monitor hundreds of planes at a time.

Office computers, business computer services, and telecommunications equipment will probably cut into the ranks of clerical workers in general and postal workers (mainly carriers) in particular. Loggers, farm workers, railway mechanics, domestic servants and shoemakers all will feel the effects of changing technologies.

While some people fear massive unemployment for the future, others predict massive retraining pro-

grams to help displaced workers plug into the new world of high technology. Futurist Marvin Cetron of Forecasters International believes there will be no real shortage of jobs in the next 20 years — only a shortage of creative, imaginative people prepared to fill them.

Think about this — before the automobile was invented there were no jobs in filling stations, automobile manufacturing plants, or automobile repair shops. People living in 1770 could not have predicted the jobs that were eliminated by and created by the automobile. In 20 years there will probably be jobs we can not even describe today. Think seriously about your career plans. Your choice of a career is a very important contribution to the good management that is needed by our society.



MANAGERS OF THE FUTURE

You have now seen a vision of the future: 200 years ago people were few, poor and at the mercy of the forces of nature; 200 years from now (barring bad luck and bad management), people will be more numerous, wealthier and largely in control of the forces of nature.

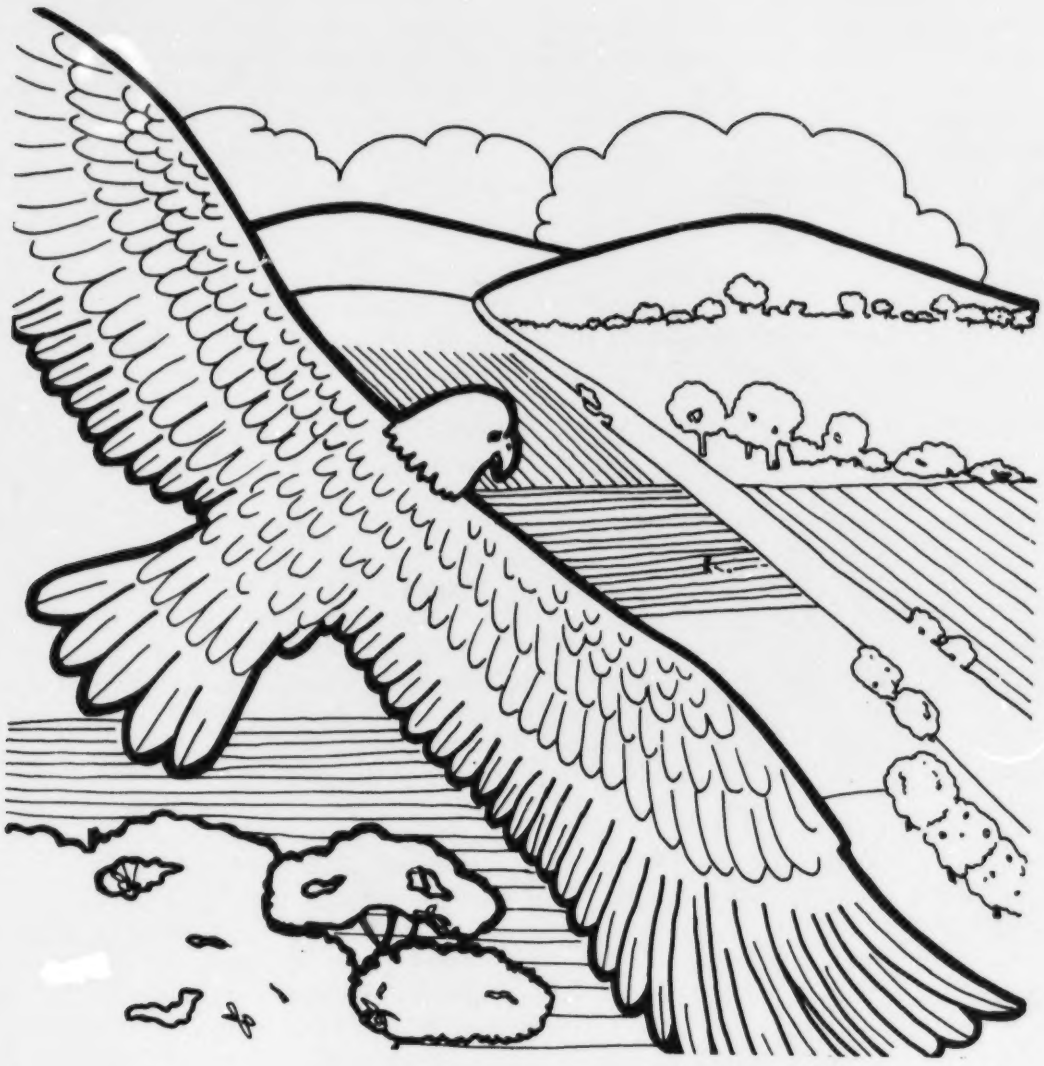
This vision, called the Great Transition, will depend on you if it is to become a reality. You and your fellow citizens will be the ones who can ensure that good management of our future occurs. What makes for good management? — seeing problems correctly, analyzing data and information accurately, knowing what tradeoffs society will have to make to achieve its goals and desires, making wise career choices, looking at the "big picture."

The successful completion of the Great Transition will *not* happen automatically. When things are going well, it is natural for people to take the positive aspects of the Great Transition for granted. When things are not going well, it is equally natural to be anxious. In good times and in bad, good managers and good management are essential.

This booklet has suggested a vision of the future in which we are all part of a historical process that, up to now, has gone well most of the time. We will always have some problems, but it seems that there are more reasons for optimism than for pessimism.

Just because things are generally going well, however, does not mean that there are not problems. And even though trends are positive, bad luck or bad management could still lead to very bad problems. This booklet has given you the information and tools necessary to develop a realistic and hopeful view of the future, and has suggested some roles you might play in making it better.

You should not assume that the Great Transition will be successful unless you become informed about the decisions that need to be made now and in the future. The concepts and tools in this booklet should make you better able to avoid bad management and handle bad luck. You also need to consider where *you* want to go, and what *you* want to make possible for your children and the children of the world. Your visions of the future are special and important.



ACTIVITIES: PROBLEM SOLVING IN A TIME OF CHANGE

ACTIVITY 18

MORE ON THE GREAT TRANSITION

A. *Trends of the Great Transition*

The events of the Great Transition are not just historical ideas. They have relevance and immediacy in your own life. The changes that are occurring in the United States at present, and that will occur during the next decades, will profoundly affect how you will spend your time in the future. Your worktime, leisure time, and family time could all be affected.

What are the *long-term* trends of the Great Transition? (In Unit II, you learned that population growth, economic growth, and growing control over nature are the major characteristics of the Great Transition. In the second half of the Great Transition, the trends begin to change as societies become super-industrial and post-industrial.)

1. With regard to *population,* the major trend of the second half of the Great Transition seems to be:

2. With regard to *economic growth,* the major trend of the second half of the Great Transition is:

3. With regard to *technological change,* the major trend of the second half of the Great Transition is:

B. *Possible Changes in My Life*
How might each trend affect *your* life? Jot down your predictions below.

Population

The population trends of the Great Transition could affect my employment in these ways:

My personal life could be affected in these ways:

Economic Growth

The economic trends of the Great Transition could affect my employment in these ways:

My personal life could be affected in these ways:

Technological Change

The technological changes of the Great Transition could affect my employment in these ways:

My personal life could be affected in these ways:

ACTIVITY 19

GLOBAL PROBLEMS

A. *Identifying the Problems*

There are basically two categories of problems which characterize the Great Transition: ***mostly understandable problems*** and ***basically uncertain problems***. Based on your understanding of these two categories, define each and list at least three examples.

Mostly Understandable Problems are defined as problems which:

_____

_____

_____

_____

Some examples are:

1. _____

2. _____

3. _____

Basically Uncertain Problems are defined as problems which:

_____

_____

_____

_____

Some examples are:

1. _____

2. _____

3. _____

B. *Explaining the Problems*

Select *one* of the "mostly understandable" problems that you named. In the space below, explain the problem. (You may want to review some of the "issues" from other units.)

C. *Solving the "Understandable" Problems*

A "Scotch Verdict" has been reached concerning the "mostly understandable" problems: they can be solved. Unless we have a lot of bad luck and bad management, they probably *will* be solved.

With these thoughts in mind, you should be able to write a realistic prediction about how understandable problems can be solved. Choose one of the mostly understandable problems you named. Then, write a one-to-three paragraph prediction about the status of that problem in 2030 (just about 50 years from now, about the time you will probably be retiring from fulltime employment!). Your prediction should utilize known facts, as well as Scotch Verdicts about the problem, and should be persuasive and well thought out. Try to convince the reader that *your* 'vision of the future' is one that is likely to occur.

ACTIVITY 20

CAREERS OF THE FUTURE

A. *Employment Trends in the Great Transition*

What jobs will be available in the near future? In the long-term future? What areas of employment will be less important in the future? Review your text, read some articles on careers, then make the lists noted below.

JOBS THAT WILL NOT BE AS IMPORTANT IN THE FUTURE

1. _____
2. _____
3. _____
4. _____
5. _____

JOBS THAT WILL BE VERY IMPORTANT IN THE FUTURE

1. _____
2. _____
3. _____
4. _____
5. _____

B. *Working to Solve Problems*

You know there are problems that must be solved. Some we understand. Some are largely unknown. We can imagine both positive and negative future scenarios. But are there any specific actions we can take?

One specific action is to prepare for an occupation in a field which contributes to *problem solving* in one of the critical areas. Fill in the chart on the next page. What work in each of these areas do you think you might enjoy?

PROBLEM AREA	SOME OCCUPATIONS THAT COULD HELP SOLVE THE PROBLEMS
Climate changes	
Adverse effects of technology (e.g., people losing jobs)	
Mismanagement of the economy	
Embargo of oil supplies	
Air pollution	
International cooperation over the use of outer space	

C. *Preparing to Work*

Could your future occupation involve you in problem-solving?

Choose an occupation that interests you. Then answer the following questions about the occupation:

1. What training is required?
2. What tasks do jobholders in this field accomplish?
3. What are some advantages/strong points about the job?
4. What are some disadvantages/weak points about the job?
5. What are the future prospects for the job?
6. Is this really a good job for your future? Why or why not? Some good resources are the *Occupational Outlook Handbook* (your Librarian will help you), and the careers section of your library (use the card catalog).

Write your answers to the question below:

OCCUPATION: _____

1. *Training:*

2. *Tasks:*

3. *Advantages:*

4. *Disadvantages:*

5. *Prospects:*

6. *My Future:*

ACTIVITY 21

THE EFFECTS OF TECHNOLOGY

You have read that the development of new technologies can solve existing problems and create new problems. Some people feel that new technologies will "dehumanize" our society.

Read the two articles that follow. Then, answer these questions.

1. Give specific examples of how technology could "dehumanize" society.

_____

_____

_____

2. In what ways could this "dehumanization" be bad?

_____

_____

_____

3. In what ways could this "dehumanization" be good?

_____

_____

_____

4. How will problems of the "dehumanization" by technology be countered?

_____

_____

_____

Reprinted from U.S. News & World Report

A Search for Life's Meaning In High-Tech Era

Traditional values of God, country and family will be strengthened even in a new age of individualism.

RICHARD KREBEL FOR USNWR

As technology grows more complex, Americans will become more intense in their search for religious meaning and spiritual well-being in a time of rapid change.

Likely to spread is belief in God or a Supreme Being to bring order and moral clarity out of technological complexity. Churches, synagogues and philosophical institutions will play a larger role in community life. Greater importance will be placed on traditional values of family, friendship and country.

"In the years to come, we should expect the quest for the sacred to intensify—from deeper religious beliefs and increased churchgoing to a resurgence of patriotism," predicts polling expert Daniel Yankelovich.

Church affiliation, forecasters agree, will grow beyond the 60 percent of Americans who are now counted as members and the 40 percent who show up for worship. This will come about in part because of lengthening life spans and the increase in the adult population, which traditionally shows the strongest interest in organized religion.

Wider offerings. Churches and synagogues will assume much greater roles as centers where people can gather to share common interests and get counseling for a range of problems from marital stress to career burnout.

Traditional boundaries separating Catholics, Protestants and Jews will continue to crumble as a result of increased intermarriage and a loosening of religious codes. No matter what the denomination, church leaders will be less dogmatic in their dealings with people.

Most significant in the changing role of organized religion will be the realignment of denominations along liberal and conservative lines.

The progressive view of mainline Protestants, Reform Jews and liberal Catholics is outward looking and egalitarian, stressing the brotherhood of human beings around the world.

This stance will be buttressed by a world that continues to shrink through global communication, increased immigration into the U.S. from non-European countries and the rapid growth of Christianity in Africa, Asia and Latin America. By 2033, the number of Christians in the Third World will swell from less than half to well over 60 percent of the planet's Christian population.

Conservative sects, such as Southern Baptists, the Church of God and Orthodox Jews, will benefit from another trend: The need of many for simplicity and certitude.

Jeffrey K. Hadden, a sociologist at the University of Virginia, says future fundamentalism will follow the guidelines of today's television preachers: "Private and emotionally intense, but not very strict. The message will be one of practical benefits—of feeling better quickly without much attention to the details of what you should believe."

The next century will also herald a new age of individualism as tomorrow's Americans look more to themselves as the frame of reference and show less allegiance to authority.

"In the future, people will have more autonomy and exert more control over their lives," says Marie Spengler, director of the values-and-lifestyles program at SRI International. This climate will open the door to more diversity of lifestyles and beliefs.

Still, for many individuals, the primary struggle will be with loneliness and the quest for human love in a world overwhelmed by too much information from computers, two-way television and the like—what Michael Marien, an editor for the World Future Society, calls the "Age of Infoglut."

William Kuhns, communications professor at the University of Ottawa, warns that unmanageable amounts of knowledge could force Americans into "tiny specialized tribes, interlocked electronically, perhaps faceless to one another, sharing a private language, a private interest, and all the time becoming more solitary and introverted."

The prospect of isolation and selfishness in such a decentralized society could give rise to small ideological communities where people of similar beliefs gather for support.

It could also spawn a new genre of spiritual free-lancing by preachers, therapists and counselors who promise instant happiness to their followers.

What concerns religious leaders is that moral values could be turned into "commodities to be acquired and disposed of according to the tastes and whims of shoppers," says Prof. Ted Peters of the Graduate Theological Union in Berkeley, Calif.

Families return to strength. In this shifting environment of high technology, futurists predict a greater role for the family unit. "By allowing people to work and learn at home, computers will restore families as society's masters and as antidotes to the coldness and clumsiness of bigger institutions," says David P. Snyder, lifestyles editor of *Futurist* magazine.

For all Americans in coming decades, one of the greatest concerns will be how to control the dangers of technology. As a result, ethics will become a matter of national policy. At Harvard University, ethicist Sissela Bok already notes sharply rising enrollment in traditional ethics courses after years of virtual eclipse.

"On issues such as nuclear weapons," she says, "technical complexities will need more and more to be balanced by fundamental human values preserved in churches and families." □

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Friday, March 26, 1982

Scientist believes technology leads to doom or utopia

By Carle Hodge
Republic Science Writer

Computers and robots will transform the world, a scientist said Thursday, in "truly staggering" ways not yet fully foreseen.

Advances in technology could put "peace and plenty for all" within human grasp for the first time, Dr. Walter Orr Roberts declared at Arizona State University.

He warned, however, that a "dreadful" alternative could be "long, dark ages" of despair and doom.

A utopian world must be pursued "with will," said the noted solar astronomer in the main address at the inauguration of ASU President J. Russell Nelson.

Roberts is director emeritus of the National Center for Atmospheric Research in Boulder, Colo., and a former president of the American Association for the Advancement of Science.

A "gigantic information revolution" is in progress, he told a Gammage Center audience, much of it a palette of the rainbow hues of academic tassels and hoods.

He estimated that half of all employed Americans now are engaged in producing or processing information — and those ranks will grow.

"As the need wanes for human labor to manufacture the material goods of society, our occupation patterns are evolving increasingly to the management of information," he said.

A computer chip the size of a postage stamp can contain 200,000 circuit elements, Roberts said, and perform tasks that would have required a room-sized computer in 1950.

Although computer circuits remain less complex than neurons of the human brain, they operate far faster, he explained.

"By 2000 A.D., the computer complexity will just about match the brain, and its speed should be perhaps 100,000 times greater," Roberts said.

"By that date, we expect computers to be about a million times more powerful than today's — or a million billion times more powerful than those of 1950.

"It is fascinating to conjecture about the uses to which such machines can be put, and the ways that we will have to devise to use them beneficially," he said.

Robots, which already are performing tasks too tedious or dangerous for humans, "are part of any realistic vision of the future," Roberts said.

He said he believes robots, like computers, will become "a humanizing force and a major factor in providing a better life for all."

He conceded, however, that "like all products of the creative mind," technology can be turned to "fearfully evil" purposes.

The world, he said, must "master the social, policial, economic and ethical forces that govern the use of our new powers."

This, Roberts argued, will be the prime intellectual task for the remainder of the 20th century, and it will not result from an armaments race.

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ACTIVITY 22

BRIGHT NEW WORLD OR GLOOM AND DOOM?

Much of the material in the *Visions of the Future* booklet focuses on the prospects of a bright new world. It has probably offered you a new perspective on issues that you previously believed would have a gloomy future. Has *Visions of the Future* changed your thinking? How? On what issues? Why?

Read the article that follows and be prepared to discuss your answers to these questions in class.

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17 scientists envision bright new world

Updated report disputes gloomy view of life in year 2000

"If present trends continue, the world in 2000 will be more crowded, more polluted, less stable ecologically, and more vulnerable to disruption than the world we live in now."
—GUESS, 2000 Report to the President, 1980

By Ronald Kotulak
Science Writer

FOR MORE THAN a decade, the prophets of gloom and doom have had their way, painting a frightening picture of the world coming apart at the seams.

But they are "dead wrong," according to a new report that concludes that the pessimistic predictions of poverty, hunger and overcrowding are based on miscalculations that are "ignorant and arrogant."

People in the year 2000 will be richer, healthier, better fed and they'll live longer than people today, according to the new assessment. Even oil prices are likely to be lower.

The new report, called "Global 2000 Revised," is the work of 17 prominent United States scientists who are experts in economics, agriculture, geology and other fields.

Directed by Julian L. Simon, professor of economics at the University of Illinois in Urbana-Champaign, and Herman Kahn of the Hudson Institute, a New York think tank, the report was to be presented Sunday at the annual meeting in Detroit of the American Association for the Advancement of Science, the world's largest scientific organization.

THE SCIENTISTS were sharply critical of the two major doomsday reports, the Club of Rome's "The Limit to Growth" and the "Global 2000 Report," an official document that has influenced crucial government policies.

The Club of Rome report has been "damned as foolishness or fraud by every serious economic critic" and the "Global 2000 Report" is "fundamentally wrong and badly misleading," said Simon.

"The U.S. public must come to hear the truth that conditions have been getting better rather than worse, and that enthusiastic and vigorous efforts to do even better even faster will benefit the public as well as the individuals who act economically to bring about this social prog-

Continued on page 10, col. 1

Economist Julian Simon: World is waiting for "good news."

World

Continued from page 1

ress," he said.

"The world is ready to turn its back on its pessimism, and is waiting to hear some good news."

Gerald Barney, an Arlington, Va. consultant who directed the "Global 2000 Report" for former President Jimmy Carter, said that though the report has some weaknesses it is "far and away the most thorough, most complete, most open, most thoroughly referenced study of world problems yet done by any nation."

"I generally stand by the report but there were some changes made by the government which I don't fully support," he said.

ALTHOUGH BARNEY did not detail his differences with government bureaucrats, the report portrayed a bleak and alarming future . . . "For hundreds of millions of the desperately poor, the outlook for food and other necessities of life will be no better. For many it will be worse.

"Barring revolutionary advances in technology, life for most people on earth will be more precarious in 2000 than it is now."

Simon and Kahn call these dire predictions "nonsense." They claim that the report was replete with major errors, its computer models inaccurate and its conclusions unfounded.

"The overall picture it paints of global trends is fundamentally wrong, partly because it relies on nonfacts and partly because it misinterprets the correct facts it does present," they said.

The revised report was originally commissioned by the Environmental Protection Agency to evaluate the Global study but when it became clear that the new study would be sharply critical of the Global report, there was political pressure to have EPA withdraw its support, said Simon. The revised report was finally completed with funding from the Heritage Foundation, a conservative think tank based in Washington, D.C.

THE SIMON and Kahn team went over the same ground as the Global report but came up with opposite conclusions:

- If present trends continue, the world in 2000 will be less crowded, less polluted, more stable ecologically and less vulnerable to resource-supply disruption than the world we live in now.
- The world's people will be richer in most ways than they are today.
- The outlook for food and other necessities of life will be better . . . life for most people on earth will be less precarious economically than it is now.

"We do not say that all is well everywhere, and we do not predict that all will be rosy in the future," Simon and Kahn said in the report.

"Children are hungry and sick people live out lives of physical or intellectual poverty, and lack of opportunity, war or some new pollution may finish us.

"What we are saying is that for most relevant matters we have examined, aggregate global and U.S. trends are improving rather than deteriorating."

AMONG THE highlights of their report, many of which are sure to be criticized by other scientists, are:

- Life expectancy has been rising rapidly throughout the world, a sign of demographic, scientific and economic success.
- The birth rate in less-developed countries has been falling, probably a result of modernization and of decreasing child mortality, and a sign of increased control by people over their family lives.
- Though there are still many hungry people, the food supply has been improving, as measured by grain prices, production per consumer and the famine death rate.
- Trends in world forests are not worrisome, taken as a whole, though there are places where deforestation is troubling.
- There is no evidence for the rapid loss of species in the next two decades that has been widely warned about.
- The widely publicized report of increasingly rapid urbanization of U.S. farmland was based on faulty data.
- Water does not pose a problem of physical scarcity or disappearance, although the situation does call for better institutional management through a more rational system of property rights.
- The climate does not show signs of unusual and threatening changes.
- Mineral resources are becoming less scarce rather than more scarce.
- There is no persuasive reason to believe that the world oil price will rise in coming decades. The price may fall well below what it has been.
- Nuclear power gives every evidence of costing many fewer lives per unit of energy produced than coal or oil. It is also very much cheaper than oil.

ONE OF THE major weaknesses of the "Global 2000 Report" is that it neglects longterm trends, such as man's ability to deal with global problems, said Simon. The growing concern over the buildup of carbon dioxide in the atmosphere and the acid rain fallout from coal-fired power plants, for instance, could be eased by converting to nuclear energy, he said.

"Our report is extremely optimistic about what the physical limits of the world will allow us to do," he said. "But it is not so optimistic about what our politics and popular psychology will allow us to do."

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